ENGINEERING NEWS

THE New York & Harlem R. R. Co. has asked the consent of Council to use electricity instead of horses on their line on Fourth Avenue. They say that they have been experimenting with a motor for a year past and are satisfied that this power may be safely and successfully used. They have the almost unanimous consent of abutting property owners. The car is to use the storage battery, the Julien we believe.

THE Oregon Railway & Navigation Company lately improvised a novel bridge at Willow Creek, where ten bents of a trestle were washed out. The wagon bridge immediately above was washed away, and this, with the ice gorge, caused the railroad structure to give away. It happened, however, that the ties, rails and stringers held together, sagging nearly to the water. Two six-inch hawsers were secured at Umatilla, and one end made fast below the break. The hawsers were hauled taut by block and tackle, and the track suspended to them in the center. In transferring, the baggage and mails were put into a push car and shot across the suspension bridge, men on the other side catching the car. Passengers walked across the bridge.

THERE were two slight shocks of earthquake in Hartford Co., Maryland, on Feb. 21, causing the buildings to shake considerably.

THE Tehuantepec Ship Railway Co. held its annual meeting at Pittsburg, Pa., on Feb. 25. The report says that the outlook was "unexpectedly encouraging." A national charter was desirable, if not accompanied by onerous conditions. A construction company is to be at once organized in New York, and to this body the Concession Company will transfer its stock. It is estimated that $25,000,000 is needed; and it is asserted that $10,000,000 can be raised at once in this country.

PANAMA news says that money is getting scarce on the canal and some of the contractors, at least, are getting anxious. The dry season is on with a vengeance and Colon suffers from a scarcity of water.

NEWS from Managua, Nicaragua, says that the canal survey progresses favorably. Of the line 10 miles are now completely surveyed. Mr. PEARY was starting (Jan. 30) for the Pacific coast with the purpose of best locating the engineers who will probably commence work there in the early part of April. There is much complaint of the manner of forwarding the mail to this section. There seems to be much looseness of method in the best of the existing routes.

ACCORDING to *Le Bulletin du Canal de Corinthe* of Feb. 15 work has not been suspended for a single day on this undertaking, but has been somewhat interrupted in certain parts—in other words, it moves slowly. The present force includes 1650 workmen.

THE Paris correspondent of the London *Financial News* says that the Panama Canal Company has a new scheme for raising the money required, despairing of the passage of the lottery loan bill in the French Chamber. The new plan proposes to issue one million of 3 per cent. obligations at par in 200,000 bonds of 500 f. each, and to give every subscriber a bond of the same nominal value but without interest in the bargain. An outside company is to receive 300,000,000 f. of the money for safe custody and investment, and against this would sign the bonds. The Canal Company would receive 700,000,000 f. cash. The bonds mentioned are to be drawn yearly, not before 15 years and not later than 90 years. The scheme is said to be looked upon favorably as the investor has a fair chance of getting back his capital even if the canal is not a success.

MR. JOHN C. TRAUTWINE, Jr., of Philadelphia, calls our attention to the fact that at Fribourg in Switzerland is a suspension bridge resembling in certain features the bridge of Mr. HILDEBRAND—illustrated in our last issue. Mr. TRAUTWINE sends a photograph and a short description and from these we can say that it spans a gorge about 300 ft. deep, with a light roadway suspended from cables anchored high above the floor in the rock; at the other end the cables are anchored also in the rock, but about on a level with the roadway. The length of the span is not given, but judging from the height of the hand-railing and certain other features on the photographs, it is not less than 600 ft. long. The famous Fribourg suspension bridge is built in the usual way and is 800 ft. long and spans a gorge 150 ft. deep.

MAYOR O'BRIEN, of Boston, Mass., has sent tothe Aldermen of that city a communication calling attention to the waste of water and the means available for reducing this waste. He is convinced that the water meter is the proper machine for this purpose, and in commenting on the late meter tests says that the Commission has only found out, "what has practically been known in the Water Registrar's department for many years," that all meters are more or less defective. The Mayor is convinced that bench tests can not be relied upon, and he much prefers the practical test of putting the meters into actual service for a period of time under actual conditions of daily use. Mayor O'BRIEN presented with this letter a report from Water Registrar DAVIS, giving his own experience with the meters actually used in that city, and he commences by stating that a perfect water meter has yet to be invented. Mr. DAVIS finds grave faults with the most approved meters now in the market, in regard to wearing qualities and accurracy of measurement.

THE annual report of the State Topographical Survey of Massachusetts announces the practical completion "of the work of preparation of a new map of the State." The work was commenced in 1884 and included the survey of 8315 sq. miles in the State, and about 600 sq. miles of abutting territory. The total cost was $115,400, of which sum Massachusetts pays only $40,000, the remainder being at the charge of the National Government. At the above given figures the total cost so far has been slightly over 2 cents per acre surveyed.

THE Third Avenue Railway Co. in this city is now trying to find out if it can legally use cable traction. The charter expressly forbids the use of steam, and as the cables must be propelled by steam, Commissioner NEWTON has refused them the permission necessary to lay their conduits. The Companys' attorneys argue that when the charter was granted cable roads were unknown, and the law was not intended to prohibit them. But the city's counsel defends Gen. NEWTON'S position.

THE Listowel & Ballybunion Railway, in Ireland, built on the Lartigue single rail system, was opened Feb. 29. The track is carried on transverse A frames standing on the surface of the ground; the carrying wheels running on a rail placed at the apex, and horizontal guide wheels bearing against side rails. The engines and cars are astride of the track. This line is 10 miles long. The locomotives, of which there are 4, have two boilers, one on each side of the track. There are 3 first class and 4 third class cars, accommodating from 20 to 24 passengers each; also two combination baggage and third class cars, 2 cattle cars, 1 horse car and 20 cars for carrying the sea sand, which is largely used for manure, as it contains a large amount of phosphates. The experiment is an interesting one, especially for Ireland, where some means of cheap transportion is much needed.

IMMIGRATION is looking up again; an almost certain sign that there is nothing like a panic or great depression near at hand, since it is a recovery following a decided check. We regret politically to see it increase, but in a business way it is a very good sign. The figures are:

	1887	1888	Incr.
Month of January.	10,302	13,238	2,936.
Seven mos. including January.	206,968	236,845	27,877.

The increase is chiefly in English and Scotch emigration, which is well, and in Italian and Polish, which is not well. Irish and German emigration are both small, and not increasing.

ENGLISH papers say that the Belgian syndicate which proposes to build a railway from Resht, on the Caspian, to Teheran, is now rapidly collecting the material. The scheme seems to have the warm support of the Russian government, and the supplies are forwarded from Europe *via* Batoum and the Transcaucasian Railway. South Russia is to furnish the labor. Plans exist for extending the line from Teheran east to Meshed, and south, to the Persian Gulf. An extension to Herat, under Russian "protection," would very naturally follow the completion of the Teheran—Meshed line—unless Russia concludes to get there quicker from Merv.

CHICAGO, St. Paul and Minneapolis railroad men are charged with projecting a railroad from that section to China, *via* Bismarck, British Columbia, Alaska and Behring Straits. There is nothing small about the project as far as its size is concerned.

THE Japanese papers say that a German firm undertook to supply a native company with rails, with the understanding that German rails were both better and cheaper than those of English make. When delivered the rails proved to be of British manufacture and were refused. The matter has been compromised, but German statements are now taken with a certain amount of caution in that section of Japan.

AS intimated sometime ago, the Philadelphia & Reading R. R. Co., seems to be really in earnest in its intentions to elevate the Ninth St. approach to the depot at Ninth and Green Sts., in Philadelphia. The company this week asked the Council Committee on Railways to defer certain actions regarding the erection of a city bridge at a particularly dangerous crossing, and gave as its reason a promise of shortly elevating the whole approach which included this crossing. The plans are being prepared and some of the officials promise that work will be commenced "within a month or two."

THE following bridge accidents are reported: On Feb. 15 an engine attached to a passenger train on the Seattle, Lake Shore & Eastern Ry., broke through a trestle across the harbor at Seattle, Wash. Ty. No lives were lost. The piling had been honeycombed by the teredo.——On Feb. 19 a freight train on the Kansas Central Ry. (U. P. Ry.), went through a trestle across Elk creek, near Holton, the trestle having been damaged by the flood. ——On Feb. 19 an engine and ten cars on the Chicago, Rock Island & Pacific Ry. went through a trestle near Wabaunsee, Kan. Two men were killed.——On Feb. 28 the bridge at South Coventry, Conn., on the New London Northern R. R., was burned. The bridge was of wood 120 ft. long, 30 ft. wide.

DURING the week much damage has been caused by floods in Kansas, and in Pennsylvania. Washouts have occurred on the Montgomery & Eufauls R. R. in Ala., the Louisville & Nashville and the Kansas Central. Landslides have occurred on the Port Deposit & Columbia, the Maysville & Big Sandy and the St. Louis & Iron Mountain roads. Much damage has been done in Pennsylvania by floods of the Susquehanna river.——A tornado occurred at Vanderburg and adjoining counties, Indiana, and around Wilkesbarre, Pa., Feb. 24.

THE most serious railway accident of the week was a collision Feb. 25, on the Union Pacific Ry., at Colton, near Sidney, Neb. An express train struck a freight car loaded with naphtha, this car being in the rear of a freight train which was being pulled onto a side track. The engine was derailed. The wreck caught fire and 8 cars of the freight and 5 cars of the express were burned. One man was killed and 18 injured.

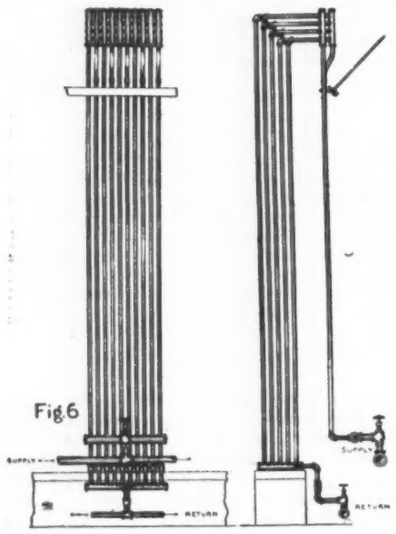
CITIZENS of East Boston want better facilities of communication with Boston proper; they think a tunnel is the proper thing, and estimate that a tunnel provided with two car-tracks, two carriage ways and a footway could be built for $600 per lin. ft. The distance to be covered is about one mile and the material is said to be good blue clay. The whole project is in the air as yet.

Heating and Ventilating System of the Mass. Institute of Technology.

(*Concluded from page 133*).

Fig. 6 shows one section of the main heating coils of which there are 11 in all. The pipes are 12 ft. long, four to a manifold and are zigzaged one pipe's space for convenience in fitting. The stack, 12 ft. high by 22 ft. broad, has an open area of 120 sq. ft. The main stack contains 3,000 sq. ft. heating surface. The main return discharges to a trap and the hot water and steam then passes through two of the eleven sections of main stack, which act as coolers. The first heating of the outside air is therefore done by 9 steam sections and 2 hot water heating sections. The steam pressure in the main pipes is about 40 lbs; in the supplementary, 5 lbs.

Fig. 7 shows the regulating valve for the supplementary heating pipes, which is placed beneath the floor of the room. The handle, carrying an index for regulating fractional openings, is now replaced by a slot, as shown in Fig. 2, the turning being done by a wrench to fit. A projecting pin limits the extent of opening.



Regulating Valve.

The most peculiar and original part of the entire apparatus lies in the arrangements for taking care of the return water. This comprises a tank, Fig. 8, open to the atmospheric pressure, connected with which is a Davidson steam pump which operates automatically by reason of a globe valve placed in the steam supply pipe, which is regulated in opening by a float in the tank. Since the tank was to take the condensation from both the main return and supplementary returns, the latter being under no pressure, and the pipes being merely gutters, while the former often had a pressure of 5 lbs., trouble was experienced with this tank, arranged as shown, by reason of the steam occasionally failing to be condensed, and in consequence blowing out. To obtain the necessary head of water in the return drip pipe to prevent this, the return pipe was extended to near the bottom of a 5-in. vertical pipe, 15 ft. long, closed at the bottom, and which was sunk in the ground. This pipe contains both the main and supplementary returns, the main drip pipe being placed inside of the supplementary return, and the arrangement forms an inverted siphon. The outlet of water to the tank is near the top of the 5-in. pipe. The water levels in the two return pipes of course stand at different heights according to the pressures, but no trouble has resulted from overflow of steam since this arrangement has been in use. Usually, the pressure in main return does not exceed 1 lb.

The supplementary system is supplied by exhaust steam from the engine, which is sufficient in amount to do all the work of these coils, and as this steam is too oily to return to boilers it is thrown away. The exhaust steam, before being discharged, is forced through the pump and then through a long pipe, 150 ft. long, which is placed inside the feed pipe to boilers. As the steam and feed water flow through in contrary directions, all available heat is extracted and goes to heat the feed water.

Connected with the pump, in a locked box, is a recording apparatus, outlined in Fig. 8, consisting of a ratchet, pencil and drum, on which is placed a sheet of paper which is revolved by clock work one turn in 24 hours. The pencil draws a line which shows the cubic feet of water condensed, A specimen chart thus produced is shown in Fig. 9. The travel shows the total cubic feet condensed, both from the main stack and supplementary coils, and by this diagram is known the time of turning on steam to rooms, amount used at any hour in the day, and it is also a check or telltale of the engineer's performances of his duties. The water condensed in main stack is also ascertained by a separate meter.

The records of this heating system for the 4 years in which it has been in operation, which are obtained by the courtesy of S. H. WOODBRIDGE, A. M., in charge, are as follows:

Heating New Building, Institute of Technology.

Year 1883-4 Month	Mean Temp.	Per cent. Cloudy weather.	Wind travel. Miles.	Coal burned.	Water condensed in heating cu. ft.	Rate of Cond'ns. lbs. equiv. per cu. ft. water.
Oct.	47.4	63	6,777	141,066	5,000	28.20*
Nov.	42.5	53	7,682	258,446	7,000	36.90*
Dec.	28.7	39	7,450	110,046	10,000	11.00
Jan.	23.8	61	8,674	238,540	17,000	14.00
Feb.	31.0	77	7,590	186,280	13,000	14.30
Mar.	33.5	65	8,751	183,386	[11,708]	15.60
April	42.7	65	7,995	105,516	7,755	16.50
May	53.8	50	7,795	50,980	2,377	21.40*
Av.	37.9	55.9	Tot. 62,717	1,294,290	73 840	
1884-5						
Oct.	52.3	50	9,288	94,500	3,825	24.70
Nov.	41.1	47	8,732	91,500	8,057	11.30
Dec.	33.1	60	8,730	159,358	14,460	11.08
Jan.	27.0	52	10,769	176,300	16,103	11.01
Feb.	20.5	44	9,244	194,400	19,385	10.02
Mar.	27.9	47	10,237	158,446	11,605	13.50
April	46.5	40	9,323	88,590	6,000	11.06
May	52.3	55	7,811	68,300	2,815	24.30
Av.	37.6	49.4	Tot. 74,164	1,031,304	82,250	
1885-6						
Oct.	51.1	56.	7,395	85,800	3,280	26.16
Nov.	43.7	62.8	9,338	93,035	7,390	12.59
Dec.	32.8	58.7	10,856	148,736	15,424	9.64
Jan.	26.0	58.6	9,323	176,700	18,032	9.80
Feb.	26.0	54.5	10,621	164,000	15,326	10.96
Mar.	33.7	59.5	10,698	154,519	14,114	10.95
April	48.2	53.6	7,664	99,808	5,156	19.39
May	56.1	53.3	8,610	72,900	1,901	38.35
Av.	39.8	56.1	Tot. 74,465	999,498	80,623	
1886-7						
Oct.	51.5	40	8,578	120,900†	3,100	35.22
Nov.	42.8	45	8,584	103,200	7,700	14.37
Dec.	28.8	59	9,913	187,200	17,300	10.83
Jan.	25.9	60	9,865	214,100	18,000	11.89
Feb.	28.9	59	9,456	184,500	14,400	12.81
Mar.	31.6	61	10,755	181,000	15,000	12.07
April	43.9	49	9,315	136,200	8,300	16.41
May	59.3	41	7,458	75,000	2,600	28.84
Av.	39.1	51.9	Tot. 73,924	1,202,600	86,400	

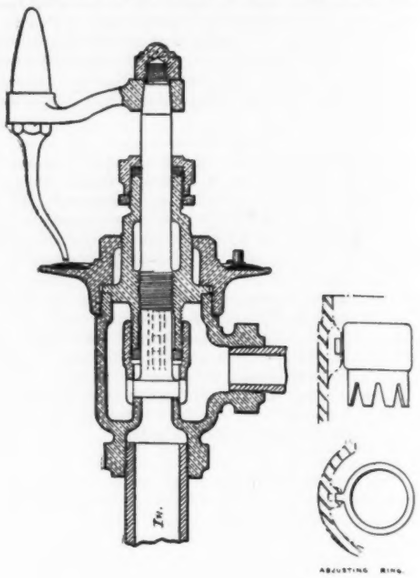
*High pressure boilers used.
†Added, 11,700 lbs. burned in September.

Summary for year.

Year.	Total coal, tons.	Used for other purposes.	Rogers B.	Heating New B.
1883-4	952	100	305	547
1884-5	823	112	307	404
1885-6	721	120	222	379
1886-7	794	236	187	371

In the above detailed table the coal burned includes that required for other purposes besides heating the new building, and is equal to the sum of the amounts stated in second and fourth columns of the summary. In 1884-5 the coal required for heating the Rogers and new building was first separately ascertained, and it shows that approximately 97 tons (difference between 307 and 404) more were required to carry out the system of ventilation in the new building over what would have been required merely for heating. The apparent reduction in coal required since 1885 for the Rogers (old) building is due to some of the steam being there used, although the coal was charged to new building.

In 1885-6 there were obtained 80,623 cu. ft. water to 379 tons coal. This is but 6.38 tons water to 1 ton coal, or an apparent evaporation of but 6.38 per pound of coal. The losses which cause this low result occur chiefly at night. For day work, the mean of 32 tests showed an evaporation of 9.62 lbs. per pound of coal, which is above the average performance of steam boilers. The conclusions drawn from this are, that economy lies in heating in the early morning with active fires, rather than in keeping up a low heat at night with dull fires; also, that in furnishing steam with one boiler doing full work, instead of using two or three with dull fires. The reduction in amount of coal of 129 tons in 1884; 230 in 1885, and 158 tons in 1886-7 is attributed to more skillful firing. Fig. 10 is a coal, water and wea ther diagram, showing the relations between these variable elements. The coal consumption and water condensation have been plotted, and the diagram is interesting as showing the effect of a strong wind, etc., on the amounts required for heating and ventilation, also the variations of a New England winter. In cold weather there is found to be required a mean condensation of 1½ cu. ft. water per hour for each degree that the outside temperature falls below 65°. Records are still carefully kept each day, and similar diagrams to those shown, made up monthly.



Section of Main Heating Coil.

On the Theories of the Lateral Pressure of Sand Against Retaining Walls.*

The various theories and formulas which have been presented for the lateral pressure of sand are all more or less defective and contradictory, either in the fundamental hypotheses upon which they are based, or in their application to limiting cases. It is attempted in this paper to point out that these defects are due to the fact that the theories assume properties of sand which are not actually true, and that correct formulas can only be established by determining experimentally the laws that govern the direction and intensity of the pressure.

The word sand implies a collection of particles devoid of cohesion, inelastic, homogeneous, and possessing an angle of natural slope. It is further supposed, if a mass of this material be sustained by a wall, that along a certain plane, called the plane of rupture, the condition of equilibrium or incipient motion exists. All theories are based upon these definitions, which in general may be regarded as a satisfactory basis or point of departure.

These definitions, however, are not sufficient to determine the direction and intensity of the lateral pressure of a bank of sand against a wall, since in connection with the conditions of static equilibrium they do not furnish a sufficient number of equations to determine the unknown quantities. Hence some further assumption is necessary, and usually this is made in regard to the direction of the pressure, and different assumptions give rise to different theories and formulas.

The oldest rational theory—that of COULOMB—as-

*Read by Prof. MANSFILD MERRIMAN, before the American Association for the Advancement of Science, August 15, 1887. From the *School of Mines Quarterly*.

sumes that the resultant lateral pressure is normal to the back of the wall. Then a prism of sand included between the plane of rupture and the back of the wall, acts by virtue of its weight against these two surfaces in known directions, and the intensity of the maximum thrust is found without difficulty. The results of this theory are practically as satisfactory as those of later authors, but a theoretic discrepancy exists which indicates that the fundamental assumption is incorrect. Thus, the point of application of the pressure on the wall is found to be at two thirds of its height from the top, but this in connection with the other conditions brings the point of application of the thrust against the plane of rupture at a different position, except for the special case of a vertical wall. Now whatever is true regarding the point of application of the thrust on one surface must be true for the other, and hence the results of this theory are logically contradictory.

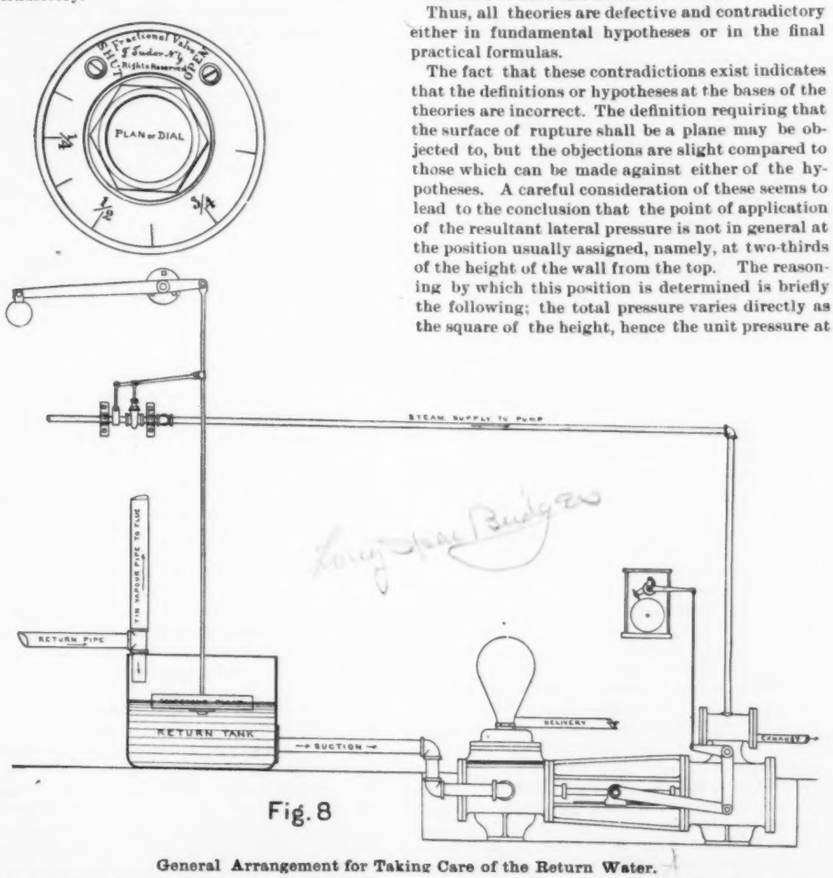


Fig. 8

General Arrangement for Taking Care of the Return Water.

The common theory—that of PONCELET—assumes that the lateral pressure against the wall deviates from the normal by an angle equal to the angle of friction, or angle of natural slope of the sand. Here the same contradiction exists as in the older theory, and to even a greater degree. Other discrepancies are also found to arise, such, for instance, that if a wall be horizontal the pressure upon it is not vertical. On the whole, the fundamental assumption of this theory is less satisfactory than that of the older method.

A late theory, due to WEYRAUCH, makes no assumption regarding the direction of the pressure against the wall. Starting with the hypothesis that the points of application of the pressures on the wall and plane of rupture must be at the same relative positions (namely, at two-thirds of the height from the top), the conditions of equilibrium serve to determine the direction and intensity of the pressure against the wall. This direction is found to vary with the inclination of the wall, being normal when the wall is vertical, and deviating from the normal as the wall inclines from the vertical. The contradictions of the older theories are thus avoided, but a new and more serious difficulty arises. Evidently the lateral pressure should decrease as a wall is inclined backward and should become zero when the wall has an inclination equal to that of the natural slope of the sand. The formulas of WEYRAUCH, however, make the resultant pressure increase with backward inclination, so that a bank of sand inclined at the angle of repose exerts a very large lateral pressure, and hence would require a wall to sustain it. This result is not only theoretically incorrect, but in practice would lead to such absurd constructions as to wholly forbid the use of the formulas for backward inclined walls.

The determination of the lateral pressure by the theory of internal stress in an unlimited mass of sand is a method followed by RANKINE, WINCKLER, and others. This theory perhaps gives the correct pressure against an ideal plane in an unlimited mass, but it cannot be the same as the pressure against a wall except for special cases, for the values are in general the same as those found by the formulas of WEYRAUCH, and for backward inclined walls lead to the same incorrect results.

Thus, all theories are defective and contradictory either in fundamental hypotheses or in the final practical formulas.

The fact that these contradictions exist indicates that the definitions or hypotheses at the bases of the theories are incorrect. The definition requiring that the surface of rupture shall be a plane may be objected to, but the objections are slight compared to those which can be made against either of the hypotheses. A careful consideration of these seems to lead to the conclusion that the point of application of the resultant lateral pressure is not in general at the position usually assigned, namely, at two-thirds of the height of the wall from the top. The reasoning by which this position is determined is briefly the following; the total pressure varies directly as the square of the height, hence the unit pressure at any depth below the surface varies directly as the depth, and therefore the point of application must be stated,—the whole law of distribution of the pressures being the same as for water. To this reasoning there seems at first no objection and none appears to have been heretofore hinted at, yet, if this be true for a material like sand, would it not also be true for a solid mass included between a wall and a plane of rupture? Evidently not; and hence it should not be taken as established that the unit pressure varies as the square of the depth.

For the case of water there is no ambiguity, since the pressure is known by experience to vary directly as the depth and to be normal to any retaining surface. Hence it follows that the total pressure varies as the square of the depth, and that its point of application is at two-thirds the height of the wall below the surface.

To render the theory of the lateral pressure of sand as perfect as that of water it is necessary to determine by experiment sufficient data regarding the direction of the pressure or the law of distribution of the unit-pressures, so that hypotheses may not be needed as the basis of theoretical investigation. When these data have been found we shall have a definition of the word sand, which, in connection with statical principles, will enable formulas for its lateral pressure to be established that shall be free from defects and contradictions.

Practically the formulas of any theory are sufficiently precise for the design of retaining walls. As a rule, walls are nearly vertical, and for the pressure against a vertical wall the different theories give results which do not greatly differ. The variation of the material behind the wall, due to rain, frost, shocks and jars, cannot of course be theoretically estimated, but must be provided for by a factor of security. Even if a satisfactory theory of the lateral pressure of earth were deduced, it is not probable that it would be more advantageous in practice than those now in use. Yet it would be an advance in science if the perfect definition for sand and the true theory of its lateral pressure could be established.

A Discussion of Long Span Bridges.

BY GUSTAV LINDENTHAL, M. AM. SOC. C. E.

1. DEFINITION OF LONG SPANS.

It is a noticeable fact, that the types of bridges most suitable for long spans, namely, the suspended arch, the erect arch, the cantilever and continuous girder types, present no advantages for short spans, and in such cases make even poorer bridges than any of the ordinary girder-types.

The ideas as to what a long span is, and where the line between long and short span bridges should be drawn, differ much.

The author suggests, as a proper classification in this respect, that all bridges in which the weight of the metal (excepting metal floor plates or buckle plates) equals or exceeds the assumed live load, are "long span bridges." Under this limit we have "medium spans" down to the limit where the plate girder becomes the preferable type of construction for "short spans." Beyond the above limit we may call bridges with metal frames having twice or more than twice the weight of the assumed live load "very long spans."

2. DISCUSSION OF CANTILEVER BRIDGES.

Most of the long span *railroad* bridges up to this time have been built on the cantilever type. It has some great advantages, but also some disadvantages, and they have not in all instances been properly weighed and balanced. The evil results of the heedless use in some cases of the cantilever type will only appear after years of experience with them; though they can be perfectly well foreseen and forejudged.

There are instances where the cantilever type has been properly selected and applied as in every way the best. But there are also instances where in the desire for cheapness of construction, durability and greatest stability and safety have been overlooked.

A main objection to cantilever bridges for any long spans is their want of rigidity. There is indeed a great cantilever bridge (with two main spans of 1,700 ft. each) now building in Scotland. But in order to provide the needed rigidity for fast trains, the expedient of making the height of the cantilevers extraordinarily great namely, 350 ft., equal to half their projecting length, has been resorted to, at the expense of head room near the shores. Such an arrangement would, for instance, not be permissible over the North river, where the full head room must be maintained for the entire width of river. But even were it permissible, the great length of span over the North river would be prohibitive from an economical point of view, if for no other reasons.

In a cantilever bridge the location of the hinges or points of contraflexure can be chosen anywhere between the supports, and the strains can be calculated on statical principles. But if the hinges are located solely with a view to greatest saving of material in the trusses, as they usually are, then their position is not necessarily coincident with the location of points of contraflexure for the smallest amount of total deflection, which determines the rigidity of the structure under transient loads. Indeed with the exception of the first one built (over the Kentucky river) all other cantilever bridges in this country have in this respect their hinges or points of contraflexure too far away from the points of support, and therefore they deflect too much.

In cantilever bridges of more than one track, excessive vertical deflection is also the cause of excessive lateral oscillation, so that when one track on a cantilever arm is loaded and the other unloaded,

the truss nearest to the loaded track will (because it gets the larger proportion of the load) deflect more than the other truss. The uneven loading brings the lateral bracing between the trusses into play with the effect that the end of the heavier loaded truss will turn or deflect around the end of the other less loaded truss, and a lateral motion is the result. Now let two trains meet on the bridge, one entering on the end of the cantilever when the last car of the other train is just leaving it, and the excessive lateral motion of the bridge will be readily understood. The cantilevers will swing like whip-ends, and the longer and narrower they are, the worse it will be, so that trains must necessarily move slowly over them.

The location of the hinges in cantilever spans is also often determined by considerations of easy erection. The suspended middle girders are usually erected by building out till they meet in the middle; the shorter these girders, the less extra material needed for the chords, and this brings the hinges far beyond the points of contra flexure for least deflection.

When there are connecting spans between cantilever spans, the material saved in the latter is nearly used up in the former in reinforcing the chords for the reversion of strains and for the heavier web members that are required as compared with a single span. The only saving then is in the erection without false works over deep or uncertain rivers.

The same and greater advantages can be secured with continuous girders having parallel chords and without hinges. An arrangement is possible by which continuous girders become calculable on statical principles and free from the well founded objections to continuous girders as generally designed. But of this type I intend to present a description and discussion later.

Along with the objections mentioned against cantilever bridges as built at present, is their general ugliness of appearance. This may not be of much consequence for a railroad bridge off in the woods, but even then it would not be more expensive to build them with an eye to better appearance, if for no other reason than to set a good example to imitative engineers. The indiscriminate use of eye-bars and bulky compression sections in the same chord lines, and the tapering form and the irregularity of truss frames is as needless as it is ugly looking.

It was only by good fortune that a certain large city in this country escaped the permanent disgrace of as ugly a looking cantilever bridge, mostly over dry ground, as ever was designed, without the least justification for the choice of this type; and another large city could be named where another ugly looking miniature cantilever bridge has actually been put up with the aid of false works.

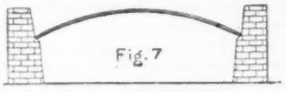
3. DISCUSSION OF THE GENERAL FEATURES OF ARCH BRIDGES.

The same reasons which induced Capt. EADS to decide in favor of ribbed arches for the St. Louis bridge apply to the proposed North River bridge. It will be interesting, and the author can do no better than to quote from Capt. EADS' report at this time the arguments of nearly 20 years ago. They are as true now as they were then, and as they always will be.

"*Arch and Truss Bridges.**—Because of the frequent assertion that your structure will be needlessly extravagant, I deem it proper to illustrate, in as simple a manner as I possibly can, enough of the general principles involved in the construction of bridges to enable any one to satisfy himself that the plan adopted for the construction of this bridge, instead of being needlessly expensive, is really the most economical of all known methods. The general principles involved in the construction of an arch or a truss are not so intricate or difficult but what any one with ordinary intelligence can, with little explanation, comprehend them sufficiently to judge for himself of the truth of this assertion.

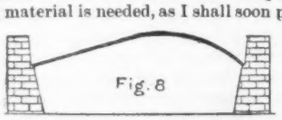
The bow-string girder (Fig. 6), requires theoretically probably as little material in its construction, in proportion to the weight to be sustained, as any form of truss known. If we support the compression member or arch of this truss (Fig. 7) between stone abutments strong enough to bear 6 tons of horizontal thrust, or exactly what its lower member must sustain, we can then dispense with the latter altogether, for it must be evident that its only purpose is to keep the bow or arch from spreading at its ends. If the truss must be supported on piers, it

will at once become an interesting question, what will be the difference between the cost of the light piers needed to uphold the truss and the heavier ones required to sustain the horizontal thrust of the arch? By horizontal thrust of the arch we mean the strain thrown by it upon the tension member in the truss. Of course, if this member be dispensed with



the abutments, or anchorage in the case of suspension bridges must sustain this thrust, and their ability to sustain it is simply a question of weight and arrangement of stone. The force of the thrust is easily known by calculation, and when we know that one cubic yard of stone will require a certain force to move it, we can readily calculate how many cubic yards of it will be required to resist a given thrust. As no account of the bond of the cement is taken in the calculation, we will have that much additional safety in the abutment. If the excess of masonry required for abutments be found to cost less than the tension member, then the arch (or the bow without the chord) will be the cheaper structure. It may occur, too, that because of the floods, ice, and drift, it may be prudent to use heavier piers than would otherwise sustain the truss. This would be an additional argument favoring the use of the arch.

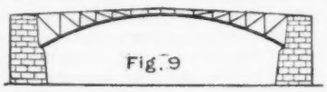
"By referring to Fig. 6 it will be seen that the bracing between the arch and the chord, as well as almost the whole of the chord itself, is suspended from the arch. In a span of 500 ft. these braces at the center of the arch would be 50 to 75 ft. long, and their weight, and that of the chord, would be enormous; yet they bear no part of the load, but serve only to preserve the form of the bow. The sole sustaining member of this truss is therefore the compression member of the arch. It must be evident, then, that by sustaining the member between abutments we not only save the cost of the tension member and bracing, but we relieve the arch of this constant and enormous weight also. Now, if this bow-string truss were simply strong enough to bear its own weight before, the same arch supported between abutments, as in Fig. 7, and relieved of this weight, would then sustain an imposed load on the bridge equally as great as the weight of the tension member and braces taken away. Indeed, if the span of the truss were 500 ft., these needless members would equal the weight of two loaded trains of cars throughout its entire length. It will be asserted that the tension member is all that is saved by using the abutments, because the bracing is needed to preserve the form of the arch also, when but one-half of the span is loaded, whether we use the tension chord or abutments. This is true, but in the latter case a much smaller quantity of bracing material is needed, as I shall soon prove.



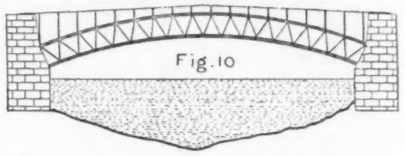
"I have purposely taken the form of truss which is of all others the most favorable to those who may be disposed to question the propriety of using the arch in the bridge at this location, because in no other form of truss with the distributed load, even in theory, can the braces be omitted.

"Referring to Fig. 7, if this arch be of equal weight throughout its length and parabolic in form, with a load equally distributed, it will be self-sustaining and will require no bracing; but when a moving load at *A* (Fig. 8), has covered that end of the arch, it will be straightened and the unloaded portion at *B* will be bent upward.

"As the strength of the arch is dependent upon its form, it is necessary to adopt such means as will preserve it in shape under all trials to which it may be subjected. The usual method of counteracting the effect of the moving load is by spandrel bracing (Fig 9). Here *AB* is a member extending over the



arch from pier to pier. To this member are secured braces and tension rods, extending from it down to the arch, to which they are also secured. The spaces thus occupied by the bracing are called the spandrels of the arch. We here have the member *AB* extending over the whole length of the span, sustaining no part of the load, but adding so much weight to the arch. Although it is not subjected to so much strain as the chord in the bow-string truss (Fig. 6), and is consequently much lighter, still it may be dispensed with altogether, if we divide the material in the arch and place one-half of it a few feet below the other, and thus form two arches with about half the original material in each, as in Fig. 10,



and brace these two arches or ribs thus made in such manner that they will preserve their form and relative distance from each other, under all circumstances. This is what is usually termed the ribbed arch, and is the form adopted for your bridge.

"We require only a little more material in the arch thus formed to carry a given load than is required in the compressive member alone of the bow-string girder, and we only need the two parts of it far enough asunder to insure sufficient stiffness to resist the strains produced by the partial load.

"Hence, we save weight (and consequently cost) in the superstructure in three ways: Firstly, by dispensing with the long, heavy bracing; secondly, by dispensing with the tension member of the truss; and lastly, by using less material in the arch, for it is plain that, as this member must sustain in either case the entire load that crosses the bridge, it must have more material put in it when it has the heavy bracing and the tension member to support also. In a long span the saving in these three items is really enormous.

"It matters not what truss be used, a proportionate excess of cost over the arch will be found to prevail in every one of them. Where there is no saving in the cost of masonry, or peculiar features of location excluding the arch, there can be no substantial argument in favor of the truss for long spans. By the word truss, I include every known method of bridging except the arch. In all of them there must be both a compression and a tension member. In the arch but one of these two members of the truss is required; the compression member when the upright arch is used, and the tension member when the catenary or suspended arch is used.

"This explanation will enable any one to understand, if he will take the trouble carefully to consider it, why an arch for the superstructure is cheaper than a truss. * * * "

4. DISCUSSION OF SUSPENDED ARCHES.

Economically considered it is clear that suspended or inverted arches offer greater advantages than erect arches for the following reasons:

a. The arches are cables formed of steel wire, which is the strongest known form of the metal. If a one inch round bar of steel will break with 80,000 lbs. per sq. in., the same steel drawn into wire of No. 7 Birmingham gauge, will stand 160,000 lbs. per sq. in. Therefore, to support a certain load on the bridge it requires only half the quantity of metal in the form of wire for a suspended arch as for an erect arch which is in compression. But, as the weight of the arches themselves in a long span constitutes a large proportion of the entire (dead and live) load; it will be seen that a great reduction of weight in the superstructure is obtained by lightening the arches themselves.

*Quotation and extract from the report of Mr. Eads to the Illinois & St. Louis Bridge Company. (May 1868.)

b. Suspended arches are in stable equilibrium, and therefore do not require lateral bracing to maintain them in position, which results in a further important saving of weight as compared with erect arches. The distance between cables, or, in other words, the depth of the arch ribs can be so regulated that the most unfavorable position of trains on all tracks at the same time will not produce compressive strains in any part of the cable. This distance between cables in the North River bridge will be 50 feet.

The rigidity of these huge suspended ribbed arches, weighing some 18,000 tons for the middle span alone, will be such that long express trains on all six tracks running in different directions at 30 miles an hour will cause no visible oscillation in any part of the bridge.

c. The great proportion of dead to live load nearly as 5 to 2, is very favorable to the running of fast trains on this type of bridge, aided by the stable equilibrium of the suspended great weight. This favorable condition is not obtainable in the same degree, nor so economically and certainly, in any other bridge system for long spans. It would be an everlasting reproach to modern bridge engineering if over such an important structure trains had to glide cautiously at slow speeds. It would practically defeat one of the objects of the bridge, namely, greater saving of time in transportation. Bridges designed so defectively that trains can pass over only at slow speed, are behind the age.

But all systems of bridge construction cannot be made equally rigid. The reasons will be made plain: As a general rule it may be stated that all bridges, in which the center line of gravity of the superstructure is above the supports, will oscillate more than bridges where the center line of gravity is below the supports. Through bridges are more rigid and stable than deck bridges, notwithstanding the diagonal cross bracing between trusses at every panel point. The load attacks the deck bridge with a greater leverage above the supports than it does in a through bridge.

Erect arch bridges with the roadway on top behave like deck bridges and they oscillate because the mass is in unstable equilibrium. Remove the lateral bracing and the arch bridge would drop into the river almost of its own weight and form

The St. Louis bridge, for example, oscillates laterally very perceptibly under passing trains or even under heavy trains, though it has a very strong lateral bracing between the arches and under the floor, as well as strong vertical cross bracing between the vertical floor struts. This oscillation is not a sign of weakness or of defective design, but a defect inherent in the system. The fine arch bridge over the Rhine at Coblentz and another at Mayence, and one over the Danube at Buda-Pesth, have the same peculiarity of a very noticeable lateral oscillation.

d. On the other hand suspension bridges presen the most favorable conditions of stability and rigidity. Not only is the center line of gravity of the suspended structure far below the points of support on the towers, but the live load attacks the structure below the center line of gravity. So the lateral oscillation of a suspension bridge is resisted by its own weight and mass.

Any one who has had the opportunity to observe the effects of passing loads on the suspension bridges over the East River, or at Cincinnati (1000 ft. span) at Niagara (800 ft. span), and in Pittsburg, will have noticed their lateral stability, notwithstanding the fact, that some of them have no lateral system of bracing at all, and others only a weak and ill designed one.

e. Wire cable bridges have the further advantage that the cables can be "cradled" or suspended in inclined planes, by which the stable equilibrium is still more increased.

It is a popular assumption that suspension bridges cannot be well used for railroad purposes, or that at least they are not so well suited as truss bridges, including the cantilever bridges. That this is a fallacy every bridge engineer will understand It is just because suspension bridges have greater stability then any other bridge system, that so much sinning is possible with them and with so few absolute failures. A suspension bridge can have any degree of flexibility and looseness of construction, but as long as the cables and the fastenings hold, the bridge cannot collapse.

There is indeed at the present time only one suspension bridge in the world (span 800 ft.) carrying a railroad; that is the one built over the Niagara river by the late JOHN A. ROEBLING; trains move over it slowly because the bridge is light. When built it was condemned by the most eminent bridge engineers then living, as unsuited to and hazardous for railroad purposes; in the face of this adverse criticism it then required greater moral courage and more abiding faith in the truth of constructive principles to build that bridge, than it would to-day to design and construct a bridge over the North River. Bridges nowadays are not built on faith. There is not another field of applied mechanics where results can be predicted with so much precision as in bridges of iron and steel.

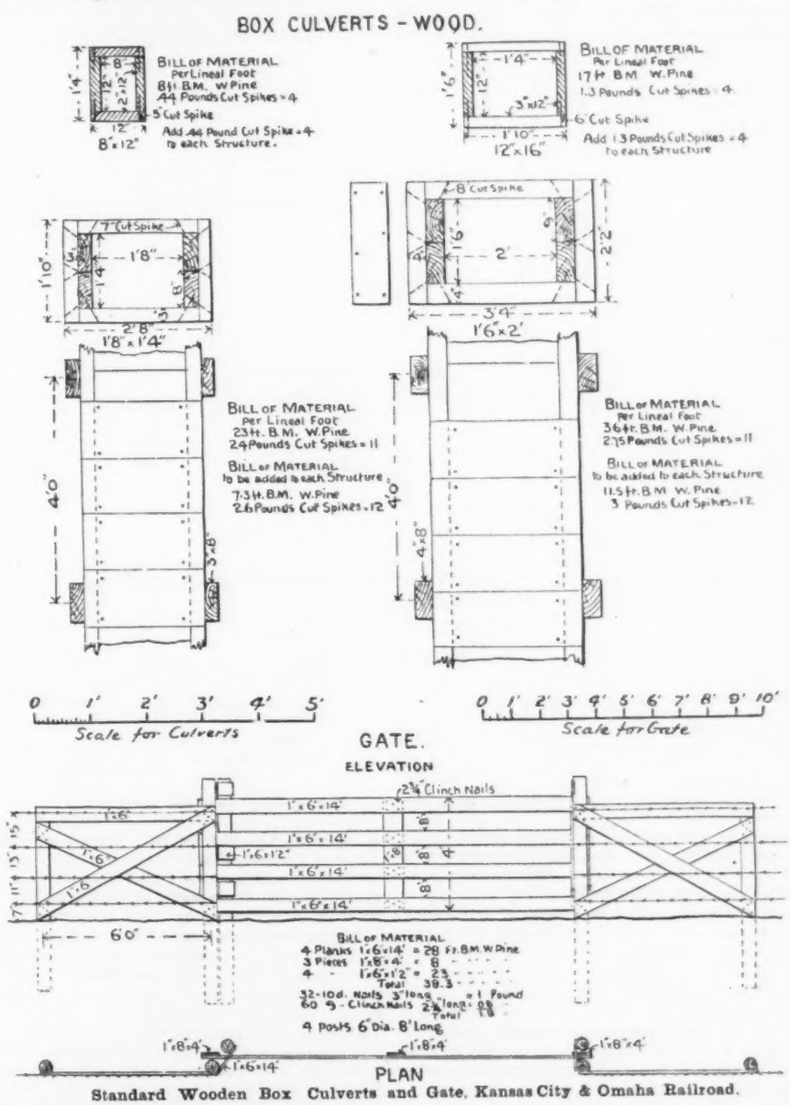
The only other railroad suspension bridge was in Vienna, Austria, built for two tracks and with about 200 ft. span. It was of a similar system to that proposed for the North River bridge; two cables close together and consisting of eyebars were braced to each other, and their curvature was very flat. The bridge was badly designed; it deflected too much and it was ultimately replaced with a three hinged erect spandrel arch bridge.

The only existing suspension bridges (both for street traffic) in which the braced cables form inverted ribbed arches are the Aspern bridge in Vienna, Austria, and the North Side bridge, in Pittsburg, Pa., the latter built by the author for a bridge corporation charging toll.

(TO BE CONTINUED).

Standards of Kansas City & Omaha Railroad.

We complete the illustrations of some of the standards of the Kansas City & Omaha Railroad, which we have given from time to time by engravings of the standard road-beds, road crossing, wooden box culverts and gate. The road-bed for excavation we regard as especially satisfactory, and


BOX CULVERTS - WOOD.
BILL OF MATERIAL
Per Lineal Foot
841 B.M. W. Pine
44 Pounds Cut Spikes = 4
5" Cut Spike
Add 44 Pound Cut Spike = 4 to each Structure.
8"x12"
BILL OF MATERIAL
Per Lineal Foot
171 ft. B.M. W. Pine
1.3 Pounds Cut Spikes = 4
6" Cut Spike
Add 1.3 Pounds Cut Spikes = 4 to each Structure
12"x16"
7" Cut Spike
1'8"
18"x14"
BILL OF MATERIAL
Per Lineal Foot
23 ft. B.M. W. Pine
24 Pounds Cut Spikes = 11
BILL OF MATERIAL
to be added to each Structure
7.3 ft. B.M. W. Pine
2.6 Pounds Cut Spikes = 12
8" Cut Spike
16"x2"
BILL OF MATERIAL
Per Lineal Foot
36 ft. B.M. W. Pine
27.5 Pounds Cut Spikes = 11
BILL OF MATERIAL
to be added to each Structure
11.5 ft. B.M. W. Pine
3 Pounds Cut Spikes = 12
Scale for Culverts
Scale for Gate
GATE.
ELEVATION
2¾" Clinch Nails
60"
BILL OF MATERIAL
4 Planks 1.6x14' = 28 Ft. B.M. W. Pine
3 Pieces 1.8x4' = 8
4 " 1.6x12' = 23
Total 39.3
32-10d. Nails 3" long = 1 Pound
60 9-Clinch Nails 2½" long = 05
Total 1.5
4 Posts 6" Dia. 8' Long
PLAN

Standard Wooden Box Culverts and Gate, Kansas City & Omaha Railroad.

worthy of general adoption, being 22 ft. at subgrade, as will be observed, against the usual 14 ft. for fills.

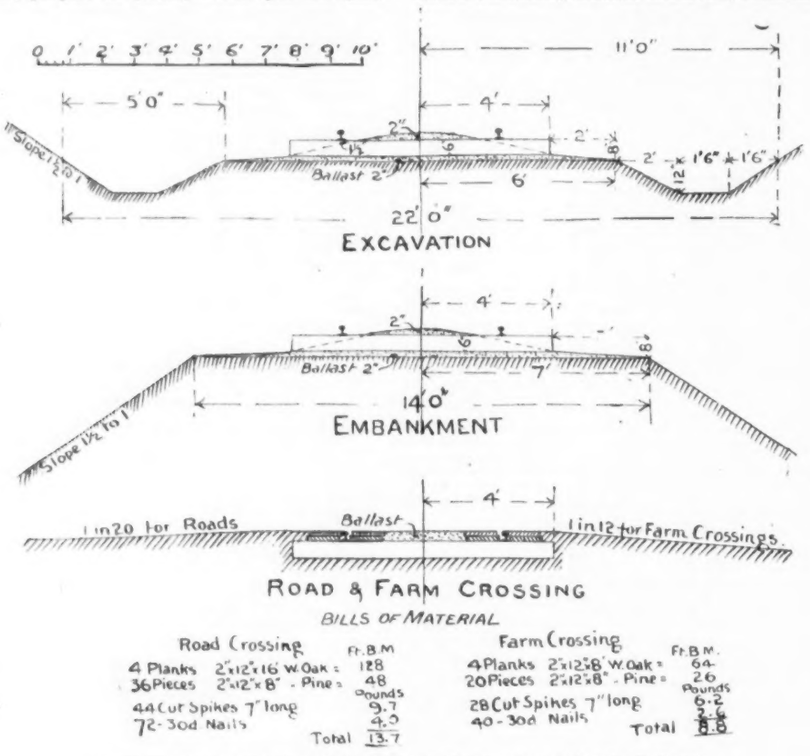
A fill road-bed of 14 ft. proves as a rule to be sufficient. The corners soon wear off, and there usually has to be more or less material added at the side at intervals, from time to time, before the fill finally solidifies, but it is difficult to say just where this will be necessary in advance, and it is questionable if anything would really be gained, in ordinary soil, by adopting a wider road-bed in the beginning.

The old favorite combination used to be 14 ft. and 18 ft., and tens of thousands of miles have been built by it, but it only needs a glance at our cuts, or a little draft upon memory by those who have had experience in maintenance, to know that it is an absurd and indefensible combination. It only allows 2 ft. extra on each side in cuts for ditching and draining. The consequence was that there was practically no drainage until the laborious removal of dirt by the track hands, season after season, in a desperate effort to keep up even the semblance of a ditch, finally widened out the cut to something like the dimensions we illustrate, 22 ft. at sub-grade. This leaves room for *good* ditches from the first, allows much freer access of the sun and air, and is

the least width in which there is any economy, especially as road-beds of this width can always be let at an appreciable lower price per cubic yard.

The box culvert drawings are for small sizes only, the largest being 2 ft. × 1 ft. 6 in., and we believe are only used in low fills and with a view to replacing them later with iron pipe. Certainly they should not be otherwise used, but the thousands of such small culverts in use, differing in no essential from these, indicates that they serve a very good temporary purpose for getting a road open and operating it during its years of poverty—a period which often covers many renewals. In former years there was a strong sentiment among engineers against covering any kind of a wooden culvert with dirt, a feeling which led to the construction of multitudes of small open culverts which were really far worse for the track and the safety of trains than a covered wooden culvert. At present the tendency is strongly to the contrary, and largely because of the recent remarkable increase in the use of iron pipe for culverts. The wooden box culverts do excellent service for many years, are entirely out of the way of fire, do not cave in even when very rotten on the inside (since they always protect the earth from access to air) never cause accident, and are very easily renewed by iron pipe of equal discharging capacity. All they need is periodical and careful inspection. These things experience has shown, and it is for this reason that their use is becoming so much more common than it was in former years.

The "gate" seems likewise a good enough design in its way, for a sliding "gate" which is really not a gate at all. The side stiffening panel is a very sensible addition which is not always thought of.



Standard Road-Beds and Road Crossing. Kansas City & Omaha Railroad.

Railroads and Minerals in the Cumberland Mountains.

The development of the mineral region in the mountain district of eastern Kentucky and Tennessee and the western part of the Virginias and North Carolina by a large number of new railway lines now under construction and survey, as shown on our recent map of the Southern States, is a matter of great interest to those interested in railway construction or the development of mining properties. It has long been known that the great wilderness lyingbet ween Knoxville, Tenn., and the Ohio river, contained deposits of coal and iron of great richness although it was not possible to profitably work them on account of their distance from any transportation lines. The Norfolk & Western Company has been the first to reach into this region and the record of their track laying for the past year given in our Railroad News of last week, shows the activity which they are fostering. The other lines which are now building into this region are the Louisville, & Nashville, Powell's Valley, Charleston, Cincinnati & Chicago, Knoxville Southern or Marietta & North Georgia and Carolina, Knoxville & Western, while the Kentucky Midland. Louisville, Cincinnati & Virginia, Carolina Central, Tennessee Midland, Kentucky Union, Southern & Western Air Line, Chattanooga, Hiawassee & Southern are the names of the principal lines which are being pushed with more or less activity by their promoters for the development of this same mineral region. In connection with this activity the following, condensed from *Bradstreet's*, is of great interest as evidence that the resources of this region will warrant the investments which are being made:

From the official report for 1887 of Mr. JOHN R. PROCTOR, State geologist, we learn that in southeastern Kentucky, in addition to the coals beneath the conglomerate sandstone forming the base of the coal measures proper, there is above the conglomerate, north of Pine mountains, 1,650 ft. of coal measures, containing nine beds of coal of workable thickness, and between the Pine and Cumberland mountains there is a greater thickness of the coal measures, containing twelve or more workable coals. One and possibly three of these coals are coking coals of great excellence, and in places two and sometimes three of the coals are found as cannel coals of remarkable richness and purity. The facts brought to light warrant the assertions that the largest known area of rich cannel coals are found in eastern Kentucky, and that the largest known area of superior coking coal is found in the same section; that this coking coal is more advantageously located, with reference to cheap and high grade iron ores, than any other coking coals. Cannel coals are found in sixteen of the counties in the eastern coal field, and analysis by such authorities as Prof. THOMAS EGLESTON, of Columbia College School of Mines, show that some of these coals excel the most celebrated coals of England. When the projected roads penetrate this region, these cannel coals will find a market all over the country for domestic use and for the manufacture and the enriching of gas. They will also bear exportation for the same purpose. The main coking coal of eastern Kentucky is a bed identified as thick coal, and traced over an area of over 1,600 sq. miles. The discovery of these coking coals adds to the value of the iron ores of the entire State.

The State geologist describes vast areas of iron ores of considerable richness in quality, variety and extent. Specular and Bessemer steel ores are mentioned as being within less than 100 miles from the Kentucky coking coal fields, and it is estimated that Bessemer pig can be made at points in Kentucky, close to the North Carolina magnetic ores, at about $5 per ton cheaper than is now done at northern manufacturing centers.

The extension of the Knoxville branch of the Louisville & Nashville R.R. several years ago, brought about the opening of various coal mines and lumber mills in Southeastern Kentucky. There is now nearing completion a branch of this extension to Pineville, which marks the first railroad line into the region which Prof. SHALER years ago predicted would some day become the center of the greatest iron and steel production in the United States. Pineville, at Pine Gap, the terminus of the now about completed branch road, is 210 miles by rail from Louisville, and only 12 miles from Cumberland Gap. It is to this gap that at least four other railroads are pushing from various points in Kentucky, the Virginias, North Carolina and Tennessee. Pineville is a specimen mountain town of this now awakening district. The place is a water gap in the Cumberland range, on Cumberland river, at the mouth of two creeks. The elevation of the mountains above the level of the river is 1,400 ft., and where the railroad is cut through, entirely perpendicular coal veins are exposed.

Iron ore crops out at an elevation of 280 ft., and what is pronounced by State Geologist PROCTOR to be the finest Oriskany ore is here found in a ledge from 15 to 25 ft. thick, assaying 56.08 pure iron, with only .008 phosphorus. Veins of cannel coal are found from 36 to 60 ins. thick in the vicinity, and iron ore, coking coal, limestone and water—the requisites for iron-making—are found in such juxtaposition as to be practically within the limits of one plant. While it has been known for ages that southeastern Kentucky had plenty of minerals, their extent and variety are only just being made known, and Prof. PROCTOR claims that the discovery of coking coals in this region is alone worth millions of dollars to the State.

As a result of the development now promised on the completion of a railroad, lands in this section which were formerly of nominal price, or at the outside held at from $5 to $10 per acre, have risen in value to $25 or $35 per acre. An English syndicate, which is building the railroad from Knoxville to Cumberland Gap, has bought millions of dollars worth of lands in that vicinity. New England prospectors, foreseeing the development, have for several years been buying large tracts of these mountain lands. The Kentuckians have awakened to the fact that outside capital is actively in the field, and the result is a lively race among various intending iron, coal and lumber operators from all quarters. The timber supply of this part of the State is vast. Throughout this section there are great forests of oak, poplar, ash, cherry, chestnut and chestnut-oak timber, as well as black walnut, spruce pine, beech and sugar tree.

A NEW way of obtaining light from gas, which is claimed to give enormously better results than the direct combustion of gas, as it certainly appears to do, is being quietly exhibited in this city to a favored few, chiefly of possible investors. The process seems technically admirable; whether the patent is likewise valuable and defensible we cannot say.

The process burns the gas mixed with air in Bunsen burner fashion around a spongy refractory substance of slight but sufficient strength against crumbling, and which is made to glow with an intense white light, with about half the ordinary consumption of gas per burner. The light-giving efficiency of the gas appears to be multiplied at least ten-fold. The incandescent substance (we are not informed of its nature) is made very cheaply by precipitating it on a very loose wick, and then burning away the latter. There is nothing in this which is theoretically impracticable, and it seems to be well worked out in detail.

Indian Engineering says that the most effective way to keep the ground floors of dwellings and store houses dry is, when building, to spread over the spot a layer of fine coal dust stamped compactly. A layer of sand of equal thickness is then laid over it, and upon that the floor. When so constructed, the floor will, it is said, always remain dry from the coal dust absorbing the moisture of the soil. The sand layer, and hence the floor, are secured from dampness and continue dry. To keep away white ants, placing of a layer coal dust under ground floors has proved highly serviceable owing to the inability of these destructive insects to make their way through it.

The Hall Duplex Steam Pump.

The latest form of the Hall duplex steam pump is herewith illustrated. This pump is of the usual American twin type, but the chief feature of interest is in the construction, arrangement and operations of the steam valves, and this is the part of the machine here particularly illustrated and described.

In the first place it should be stated that there is no mechanical connection between the piston rods and the valves, the latter being entirely worked by steam. The method in which this is performed will be best understood by reference to Fig. 1, which is not intended to show the actual constructive details, but merely to serve as an illustrative diagram, by means of which the course of the steam passages and action of the valves may be followed. The main steam cylinders I and II are served by the slide valves s_1 and s_2 of the ordinary shape; but there are separate passages for the steam and for the exhaust communicating with the cylinders at a_1 a^1_1 a_2 a^1_2 and b_1 b^1_1 b_2 b^1_2 respectively, the exhaust ports b being further from the end of the cylinder than the steam ports a. Forming parts of the same castings as the valves s_1 and s_2 respectively, are the double slide valves v_1 v_2, which in reality work upon the same faces as the former: but instead of being placed as in the diagram, they are arranged side by side, as shown in Fig. 4.

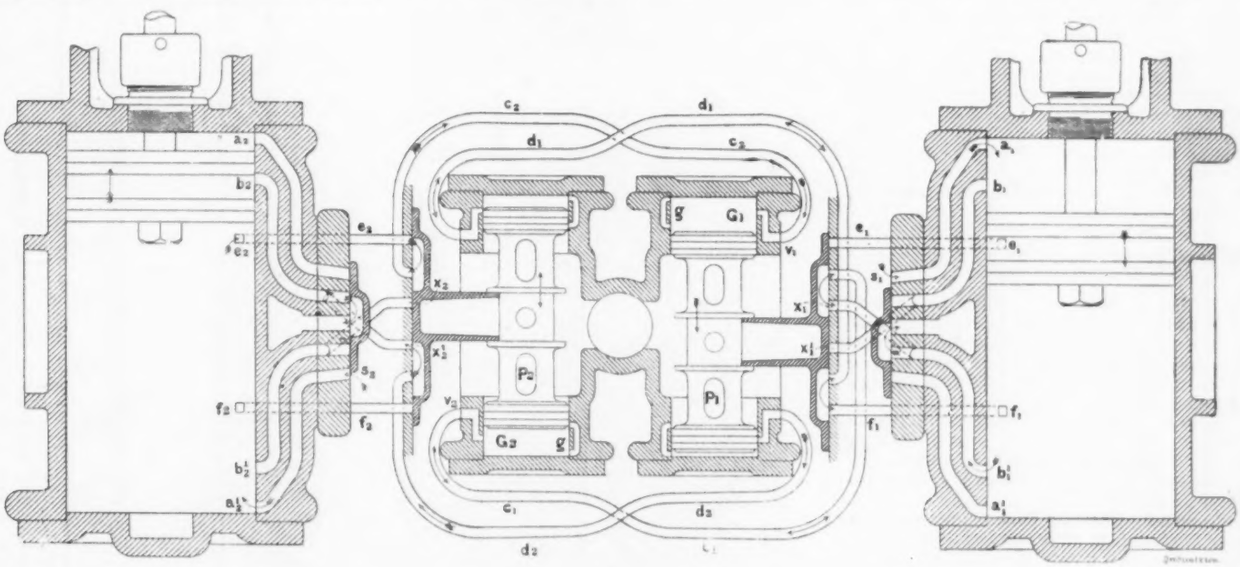


Fig. 1.

The valves s_1 v_1 and s_2 v_2 are controlled by the auxiliary steam plungers p_1 p_2 respectively, working in the cylinders G_1 G_2. The valve v_1 regulates the admission of steam to the passages e_1, e_1 f_1, d_1, $x_1{}^1$.

The passages e_1 and f_1 connect the cylinder II with the interior of the valve v_1, while c_1 and d_1 communicate with the ends of the auxiliary cylinder G_2. The ports x_1 and $x^1{}_1$ open into the main exhaust passages of the cylinder II. It will be evident from the diagram that the valve v_1 connects the spaces behind the pistons of the plunger p_2 in the auxiliary cylinder G_2 alternately with the main steam cylinder II and the exhaust passages of the latter. In an exactly similar manner the double valve v_2 controls the passages e_2, c_2, f_2, d_2, x_2, and $x^1{}_2$, and admits steam through e_2 and c_2 or f_2 and d_2 from the main cylinder I to either end of the auxiliary cylinder G_1 and exhausts it from the latter by c_2 x_2 or d_2 $x^1{}_2$. Thus, the double valve v_1, operated by the plunger p_1, regulates the motion of the plunger p_2 while the double valve v_2 operated by the p_2 regulates the motion of p_1. As the main slides s_1 and s_2 are rigidly connected with v_1 and v_2, they of course move with the latter. To make the action of these valves clear, let us suppose that the piston of cylinder I has nearly completed its stroke to the left, and uncovered the passage e_2, the valves v_2 and s_2 being in the position shown in the diagram. In that case, the live steam entering the cylinder through a_2 flows out through c_2, under the valve v_2, by the passage c_2, to the back of the left hand piston of the plunger p_1, and forces the latter over to the right into the position shown, and with it the valves s_1 and v_1. This opens the admission port a_1 to the left of the piston in cylinder II, and connects the space to the right through b^1 with the main exhaust passage. At the same time the steam at the opposite end of the plunger p_1 escapes through d_2 and $x^1{}_2$ into the main exhaust of cylinder I. By the opening of port a_1, steam is admitted on the left of the piston of II, which had previously been at rest, and starts it on its stroke to the right. When this piston uncovers ports b_1 and e_1, no effect is produced, because these ports are closed by the valves s^1 and v_1; but when it uncovers f_1 live steam will pass through this port and through d_1 to the left end of the auxiliary cylinder G_2, forcing over the plunger p_2 to the right, and with it the valves v_2 and s_2. In the meantime, the steam to the right of plunger p_2 escapes through c_1 and x_1 into the exhaust passage of cylinder II. The movement of the valve s_2 starts the piston of cylinder I to the right, and the same cycle of operations is repeated.

The passages d_1 c_1 and d_2 c_2 enter the auxiliary cylinders at a little distance from the ends, and thus leave spaces beyond them for cushioning the plungers p_1 and p_2. This cushioning action is increased by the following device: A small passage g is formed in the wall of each auxiliary cylinder at either end, and communicates by two apertures with the latter. When the valve piston passes over, live steam flows from the steam chest through the passage g to the back of the piston, thus stopping its motion by filling the cushioning space. The plunger is then balanced, having live steam at both ends. Assuming the plunger p_1 to be at the right end of its stroke, as shown in the diagram, then as soon as the valve v_2 moves to the right sufficient to uncover the exhaust port x_2, the space at the left end of G_1 is opened to the exhaust, and the greater pressure of the live steam at the opposite end will drive the plunger p_1 a short distance to the left, sufficient to close g and uncover the opening to d_2, so that steam from the cylinder I may be freely admitted and drive p_1 completely over when the valve v_2 has arrived at the end of its stroke.

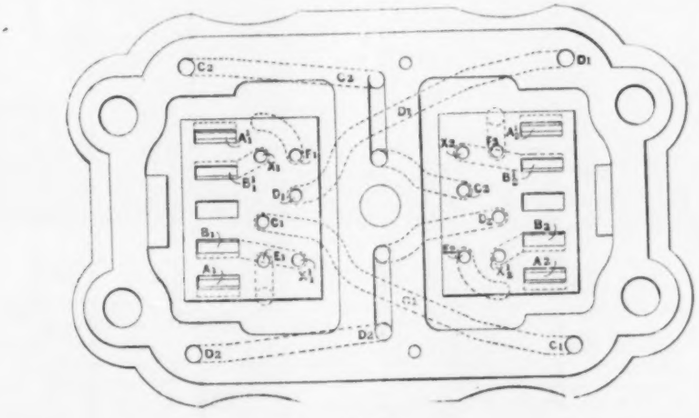


Fig. 2.

It will be seen from the preceding description that the valves of one main cylinder are worked by the steam from the other, and that before one piston comes to rest the other starts, so that there is always a continuous flow of water delivered by the pump. The pump can be started at any point of the stroke.

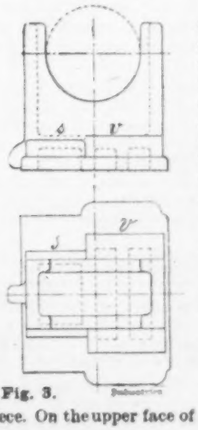


Fig. 3.

Coming now to the actual construction, as distinguished from the arrangement shown in the diagram, the vale chest and auxiliary, or or valve cylinders, which form one casting, are bolted to the top of the main cylinder casting. Between the latter and the former is, however, a separate piece, Fig. 2, which the makers term the "steam plate." This has parallel faces fitting accurately against corresponding surfaces on the steam chest and cylinder casting, and forms, so to speak, a packing piece. On the upper face of the steam plate work th

slide valves S_1 V_1 and S_2 V_2, shown in Fig. 3: the ports controlled by V_1 lie on two parallel lines e_1 c_1 and x_1 in one line, and f_1 d_1 $x^1{}_1$ in the other. The valve V_1 consists practically of two similar valves, side by side, with a partition between one side corresponding to ports e_1 c_1 x_1, the other to f_1 d_1 $x^1{}_1$.

In Fig. 2 the ports in the face of the steam plate are denoted by the same letters of reference as the corresponding passages in Fig. 1. The valve v_2 is exactly like v_1 in construction, except that one is right and the other left handed; it controls the ports e_2 c_2 x_2 and f_2 d_2 $x^1{}_2$. The cross connections between the various passages, which are of rather a complicated character, are formed by grooves in the lower surface of the steam plate, as shown in Fig. 2. This explains the necessity for the use of the plate. The attachment between the valve and the plungers is indicated in Fig. 1. On the back of each valve—or, rather, set of valves—is a projection with a semicircular recess which embraces the plunger, and against which fit flanges formed on the latter. The admission of live steam to either end of each plunger, for the purpose of cushioning, is a special feature in the valve arrangements, on which the makers lay great stress, it obviates the difficulty which has frequently been experienced with steam worked valves, that the plungers, or valve pistons, are prematurely shifted by back pressure in the cylinders. These pumps are made by the Hall Steam Pump Company, of New York, for water and sewage works, and the smaller sizes for hydraulic elevators, cranes and other machinery.

Montreal Terminus and Viaduct Approach, Canadian Pacific Railway.

We publish the accompaning illustrations of the new Montreal terminus and viaduct in the hope that it may make some of our rich American railways ashamed of themselves, as well as for the general information of engineers. With the partial exception of New York and Philadelphia, where a vastly greater traffic has had somewhat similar approaches furnished to it, after it became well nigh a physical impossibility to handle the traffic by any less permanent method, this is the first work of the kind on the continent.

To be sure, the Canadian Pacific is not exactly a pauper. In fact, it has been irreverently dubbed by one of the New York papers "the Canadian Government on wheels," and it certainly does that Government credit, and the Canadian people generally, by the way in which it represents them, since its equipment and management is in many respects the best of any roads on the continent. But its traffic is light, and the fact that it puts up so fine a station and approach of its own accord in a rather small city like Montreal, is a striking commentary on the way in which our American roads do *not* do it, to carry vastly larger traffic into vastly larger towns.

The total length of the work now let, and shown in our engravings, is 1,705 ft., 1,305 ft. being over arches, and 400 ft. of retaining walls. This is exclusive of the fine station building, of which we shall give further details and another engraving in a later issue. The architect is Mr. BRUCE PRICE, of New York, who has done some excellent work of other kinds, for railways as notably the original bay-window parlor car for the Pennsylvania Railroad.

The cost of the viaduct, of which we shall give details later, is not so very great, even in first cost, as will appear from the following comparative estimate, while in yearly cost of maintenance the stone viaduct is far ahead:

Quantities in 25 ft. Length. (20-ft. arch and 5-ft. pier).
Average height, 23 ft. 6 in., ground to base of rail.
Foundation, 4 ft. 6 in. to 5 ft. deep, on hard gravel.

First class masonry, in cement	192 cu. yds.
Broken stone filling for spandrels	21 " "
Ballast	48 " "
Timber guards, 2 lines, 12 ft. × 12 ins	600 ft. B. M.

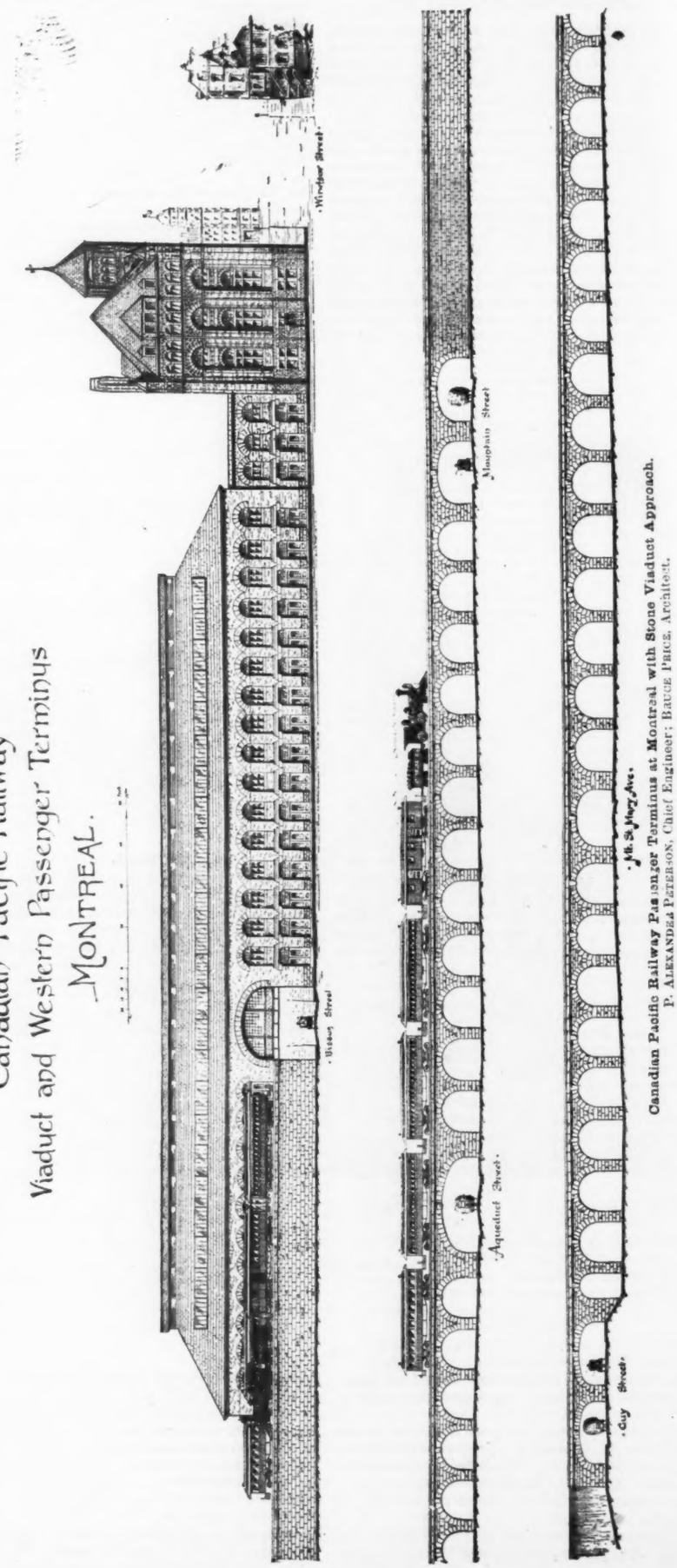
Comparative Estimate on Basis of Annual Cost, between Masonry Arches and Iron Trestle—double track

MASONRY ARCHES.

Interest, 5% on cost of $92 per ft =	$4.60
Maintenance of two lines of track, and renewal of timber guards =	0.15
Annual cost per foot =	$4.75

IRON TRESTLE.

Interest, 5% on cost of $77 per foot =	$3.85
Flooring @ $8 per foot, renewable every 8 years ⅛ of $8 =	1.00
Painting @ 80 cts. per foot, renewable every 5 years. ⅕ of 80 cts. =	0.16
Inspection and adjustment =	0.04
Annual cost per foot =	$5.05



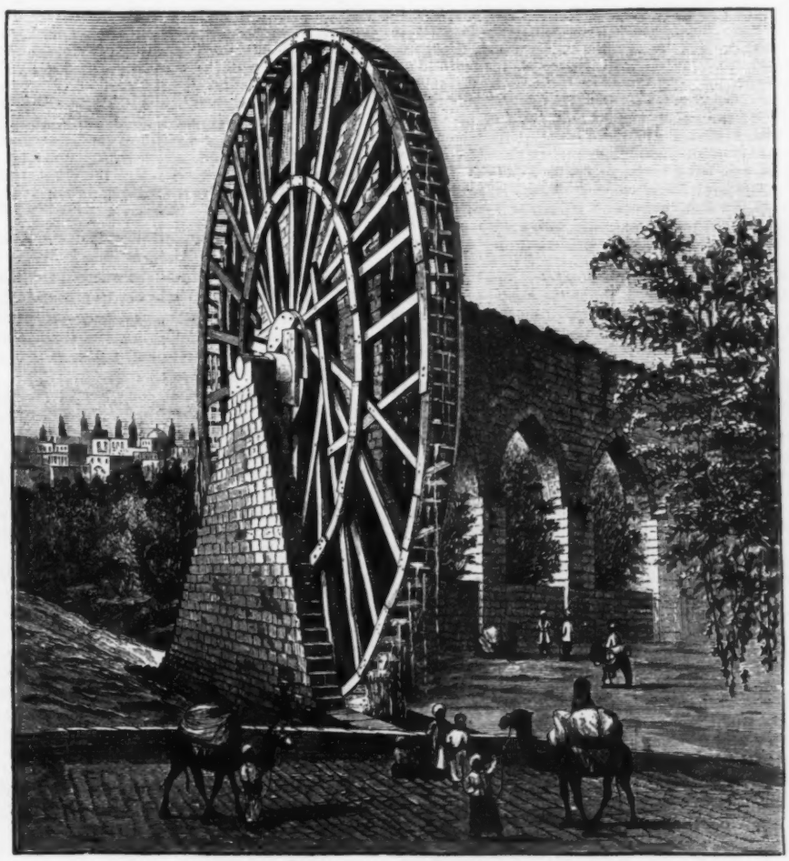
Canadian Pacific Railway Passenger Terminus at Montreal with Stone Viaduct Approach.
P. ALEXANDER PETERSON, Chief Engineer; BRUCE PRICE, Architect.

It will be well for a good many engineers to study these figures until they have them by heart.

Temporary construction, wood instead of iron, and iron instead of the slightly more costly stone, in localities to call for stone, is largely a mere survival in this country; a tradition inherited from the days when the last degree of economy was necessary, and which is adhered to long after the necessity for it has passed from a kind of mental inertia. Buffalo, Chicago, Pittsburg, Indianapolis, Jersey City, Boston and a host of other places ought to have their roads carried into them in solid and safe fashion, instead of with the present barbarous grade crossings and other like details, and in very many cases it would be an actual saving of money to do so, while in none would it cost much. We leave our engraving, however, to preach the rest of the sermon.

A Syrian Water-Wheel.

The water-wheel shown in our illustration is rather more interesting for its picturesque effect



A Water Wheel, at Hannah, Syria.

than for its efficiency as an elevator of water. It is one of six similar wheels used for supplying the town of Hannah, in Northern Syria, with water from the ancient Orontes river; or the now so-called Nahr-el-Asi. This wheel is 80 ft. in diameter and is a type of many hundreds to be found in this country, each wheel being the property of a different company, or association of owners. But as they are made of wood and will decay, in this easy-going land they are usually in even a more dilapidated state than the one depicted.

As Hannah itself has 43,000 inhabitants and the neighboring town of Hom has 23,000 more, it would appear that some Yankee vendor of turbines, or something more in accord with the times than this ancient improvment on the more ancient Egyptian *Shadoof*, would have a field for his enterprise. If this same Yankee were to simply improve upon the form of the water-wheel itself, he would doubtless greatly benefit this thirsty land where water is of all things the one most desired. One point of interest in the wheel shown, is that in its construction traditions have been followed that are as old as the 'Arabian Nights" itself; it is the work of a people very slow to change and this same conservatism might interfere seriously with the business prospects of anyone who would attempt to introduce better things.

The Use of Steel Tapes in Surveying.*

The measurement of a distance to a specified degree of accuracy is a truly scientific problem, requiring a thoroughly rational and scientific treatment to *ensure* the desired result. That two or more measurements should agree, is evidence that the sum of all the errors in the one are equal to the sum of all the errors in the other, but it is no evidence whatever, that these sums are zero, or that both measurements are correct. The only *assurance* we can have that the work is correct, is that which comes from a *knowledge* that no errors have been made, larger than certain maximum limits, which limits have been rationally studied and evaluated.

The limits which should be set to the several kinds of errors, depend on the degree of accuracy desired in the work, a highly accurate measurement requiring many precautions which could be partly or wholly neglected where larger errors may be tolerated. Engineers and surveyors may now consider themselves exceedingly fortunate in having at small cost an instrument which readily adapts itself to all kinds of field measurements, from the wildest running survey to the most accurate determination of the lengths of base lines. This instrument is the steel tape. They are furnished of all lengths, graduations and cross-sections, so we have but to decide what will best suit our purpose, and turn to the trade catalogues and find it.

In this paper three grades of accuracy will be considered, and the corresponding dimensions of tape, and methods of measurement discussed. Before we can rationally determine the limits of error from each of the several sources of error, for a given degree of accuracy in the final result, it is necessary to discuss the different kinds of errors, and determine the laws of their combination.

There are two general classes of errors, cumulative errors, and compensating errors. In measuring lengths, any error in the assumed length of the tape itself is a cumulative error, that is all the errors go the same way, so that the *proportional* error of the result is the same as the proportional error in the length of the tape. That is, if the tape is 0.1 ft. too long in 100 ft., its proportional error is 1 in 1,000, and if a line were to be measured with this tape its proportional error would also be 1 in 1,000 from this cause alone, regardless of its length. Other errors of measurement are compensating errors, that is, they are as likely to be of one sign as another, and hence will largely balance, or compensate each other in the final result. The law of probabilities shows that in such cases *the square root of the number of errors probably remains uncompensated*. Thus, although there is an accumulation of residual error, this error does not grow as fast as the length of the measured distance increases, and hence the *proportional* error from this cause grows less and less as the line becomes longer. If we wish to measure a line with an *assured* accuracy of 1 in 5,000, and the error in the length of our 50-ft. tape, at the given pull and temperature, was 0.01 ft., then this error alone would ensure an error in the final result quite up to our limit, and all other errors would have to be reduced to zero. Since this latter cannot be done, it is evident that the absolute length of the tape in use must be known much nearer than the standard of accuracy set for the field measurement. It is the writer's opinion that the absolute length of the tape, at some standard pull and temperature, should be known to *one-fourth the relative error set for the field measurement*, when the tape is held in the hands and plumb-lines used for obtaining ground points.

For any single piece of work, the pull used, the angle made with the horizontal, and the temperature at which the work is done, become also cumulative errors, if these have one sign for the whole measurement, which is apt to be the case, but since they will vary considerably on any line measured, the individual errors will not be always at their maximum value, and hence these errors do not fall strictly in either class of errors described above. They deserve a separate treatment, as their accumulation is more rapid than a true compensating error, but not so rapid as a strictly cumulative error.

To find a rational rule for obtaining a limiting value for a strictly compensating error, the square root of the number of which remains uncompensated we have

$$e = \tfrac{1}{4}\, r\, L \sqrt{n} \qquad (1).$$

where e is any compensating error for one tape length.

r is the relative error for the entire line.

L is the length of tape.

n is the number of tape lengths to be measured.

The factor $\frac{1}{4}$ is introduced in order to make the accumulation from any one source of error one fourth of the entire limit for the line.

If $r = \frac{1}{2000}$; $L = 50$ ft.; and $n = 100$; then we have for the limiting value of a compensating error on a line one mile in length,

$$e = \frac{50 \times 10}{4 \times 2000} = 0.06 \text{ ft.}$$

For ordinary farm surveying, the average length of line is about a half mile, or 53 tape lengths, whence for this case

$$e = \frac{50 \times 7.3}{4 \times 2000} = 0.045 \text{ ft.}$$

The making and connecting with the ground marks is the only strictly compensating error of appreciable size, and the error in true length of tape is the only strictly cumulative error.

We have now found that for an assured accuracy of 1 in 2000 in the final measurement of a line one-half mile in length, with a 50 ft. tape, each strictly cumulative error must be less than 0.006 ft. and each strictly compensating error less than 0.045 ft. for a single tape length. The limits for the sag, stretch

*Read before the Ohio Society of Surveyors and Civil Engineers by J. B. JOHNSON, Prof. Civ. Eng'ng., Washington University St. Louis, Mo.

and slope errors will be intermediate between these limits, approaching the minimum of 0.006 ft. as they are more constant in sign and amount. Perhaps 0.02 ft. would be a fair average limit for these sources of error. The temperature error is a strictly cumulative error if the average temperature of the line is taken.

The limit of accuracy of 1 in 2000 for the entire line has been chosen as one which is readily attainable in country surveying, without any material increase in cost, as we hope to show. In rolling and hilly country a 50 ft. tape is preferable, but in flat country a 100-ft. tape would be found most expeditious and accurate. The old 66 ft. standard must give place eventually to these decimal lengths. The cross-section best adapted for this work is probably about ¼ in. in width and 0.012 in. in thickness (No. 30 Birmingham wire gauge). This would weigh 0.01 lb. per ft. or ¼ lb. for 50 ft. being 0.003 sq. in. in cross-section.

TO BE CONTINUED.

Railroad Consolidation in Massachusetts.

The Massachusetts legislature has finally voted to pass the bill permitting the lease of the Boston & Providence Railroad to the Old Colony to be confirmed. There was much opposition to the measure, but common sense finally carried the day. A thoroughly excellent argument was made by Senator GLINES, chairman of the committee who reported the bill, a part of which we condense:

"The first question is, should two business corporations be allowed to consolidate their business upon terms satisfactory to both; and the second question is, whether there are any reasons of public policy or any public interests that should prevent the desires and agreements of the parties from being carried out. It would seem to be a sound general proposition that two companies should be permitted to consolidate, unless it is against public policy or the interests of the people or the State. If the rights of the State, of the public, and of the companies are protected, then there can be no reason why the union of two companies should not be allowed.

"Whether the common operation of the roads is for the public interest, and they can thus be operated more cheaply, seems hardly to be open to discussion. Nobody denies it. It appeared from the evidence that $50,000 saving per annum would be the result of the consolidation. The salary list of the Providence road amounts to $37,000, on which alone there would be a saving of from $25,000 to $30,000.

"Here is the Providence road, 44 miles long; and with all its branches, 67 miles long, interlocked with the Old Colony at six points—entirely surrounded by the Old Colony, which has 475 miles of track. The two roads have joint trains, and a joint business of from $200,000 to $300,000. If a business man owned these two pieces of property, would it occur to him to run them separately? The Providence cannot extend. It is landlocked in every direction by other roads, and unless the consolidation takes place must remain substantially a local road. It is contrary to the public interest that the operation at reduced expense and with increased accommodations should not take place.

"The consolidation of roads has always as a rule been accompanied by a decrease of rates. It is not for the public interests that roads should ruinously compete and do business at less than cost; but by consolidation and consequent reduction of expenses the consolidated company has often been able to profitably do business at prices at which the separate companies would have lost.

"The policy of the State has been for consolidations. During the past 20 years the railroads, first built in short links, have been gradually included in large systems, and while this has been going on, the reduction of rates has been going on to as large an extent. Who would prefer to-day to have the Boston & Albany consist of independent roads, as many years ago it did and would not say that the consolidation was one of the most useful things that ever happened in the railroad legislation of Massachusetts. EDWARD ATKINSON said in substance that the reduction, since the war, in rates on lines between the East and West has been more than the whole cost of the war. Whether that is correct or not, there has been a great reduction. From 4 cents per mile per ton, about 15 years ago, the price has at times been reduced to four-tenths of a cent per ton on many roads. In 1879, the average rate of fare on all the roads in this State was 2¾ cents, and now it is 1⅞ cents. In 1881, it was 2 cents per mile on the Old Colony, and now it is 1½ cents per mile. During the past 20 years the union of roads has gone on at a surprising rate, accompanied as a rule by constantly decreasing rates of fare and freight.

"The committee came to the conclusions that the interests of the State, of the people who patronize these roads, and of the public generally, will be promoted by permitting the consolidation of these railroads, and after careful consideration of the whole subject, and of the evidence and argument, reported the bill which is now under consideration. We believe that if this becomes a law, the future will show that our reasons and action were well founded, and that benefit has resulted to all, and evil to none."

Locomotives for New South Wales.

The following is from *The Colonies and India*, London, England, with reference to the recent proposals for locomotives for the colony of New South Wales, Australia:—On more than one occasion reference has been made to certain specifications sent out by the New South Wales Government, for the building of fifty locomotives by colonial manufacturers. It will be remembered that the tenders were on this occasion restricted to colonial men (1) with the view to compare their prices with those of outside competitors, and (2) to satisfy a pressure which was brought to bear on the Government in respect of having Government work done in the Colony. These tenders have been opened, and they will prove highly suggestive to those who know what they can be done for in Great Britain. The Atlas Engineering Co., passenger engines, $16,315; freight, $19,200; first engine to be supplied within 9 months after date of acceptance of tender, and one every month subsequently. Hudson Bros. (Limited), Mort's Dock Engineering Co., H. Vale, and Morris Bros. jointly: passenger engines, $17,760; freight engines, $19,600; first engine and tender to be delivered on Jan. 1, 1889, and one every month thereafter, the whole contract to be completed by the end of the year 1891: Thomas Wearne, for 12 engines—passenger, $17,250; freight, $18,800, the first engine and tender to be delivered by Feb. 17, 1889, and one engine and tender every two months from that date, completing the contract by Feb. 17, 1891.

When tenders were received in June last from colonial manufacturers for 50 locomotives (in accordance with specifications prepared by Mr. Midelton) to be manufactured in the Colony in pursuance of the resolution passed by the Legislative Assembly providing for the manufacture in the Colony of 100 locomotives, the prices submitted were:—Hudson Bros., freight engines $20,250, passenger engines $18,490; G. A. Key, freight, $19,800, passenger $18 525; H. Vale, freight $19,800, passenger $18,250; Mort & Co., freight 0,400, passenger $18,510; Atlas Co., freight $20,050, passenger $18,575; J. Munday, freight $14,370; passenger $14,370; T. Wearne, freight $19,900, passenger, $18,570; Morris Bros. freight $19,050, passenger $19,000; J.B. Brown, freight, $17,300, passenger $17,300. The first six firms tendered for only 15 engines of each class, and two other firms for only 10 of each.

The lowest tenders received in England for locomotives, when the manufacture was thrown open to the competition of the United Kingdom, the Continent of Europe, and America, in April last, were as follows:—Dübbs & Co., freight, $10,975; Beyer Peacock, passenger, $12,475; Neilson (Glasgow), freight $11,225, passenger $11,875. The two first named firms failed to comply with the conditions of the contract. This is a matter which might occupy the attention of the Associated Chambers of Commerce at their forthcoming meeting. The colonial tenders are a full $5,000 higher per engine than the English.

Markets for the Week.

From the standpoint of the mill and shop manager and building contractor, there is but little ground for enlightened apprehension as to the character and volume of the business of the incoming season. Eastern views and opinions of practical matters are largely tinged with to-day's or yesterday's financial situation and prospects, or, with what Congress may do or may not do, or with the influences which for the time being, like froth float upon the surface of trade.

Opinions in the great interior are formed out of somewhat different material, and while not ignoring railroad trade and financial factors, they are obliged to occupy a subordinate place, as they should. The real situation from the average business man and manufacturer's standpoint is in a few words this: There is a larger volume of work projected outside of railroad building, than for years. "Where is it, for heaven's sake," shouts the pessimist. "Right there coming onto us, mountain high," shouts the optimist. Both are wrong. Even the railroad builders will build considerably more road than the editors of the financial columns of eastern journals will allow them to build.

Already the rail makers have sold one-third of their capacity, and there are inquiries and opportunities in sight that if the question of prices were definitely fixed, would take the biggest part of another third between now and May 1st. It is true there is a greater than usual degree of conservatism displayed, and it is well this is the fact. Business is being purposely and wisely held back in several industries. A ten per cent. reduction in wages will sweep over a good many of them, and it is the observation of this fact that is causing delay. Schedules control rates of pay in a greater number of industries than ever, and includes a larger number of men this year than last, but there is room for a wide swath to be cut, and it will be cut. The iron and steel makers have considerable business on hand. Rail buyers hold back orders. Bar, plate, sheet and merchant steel makers all see their way clear to a large increase in business. The demand for railway equipments and supplies will be heavy this year, no matter to what extent railway wars and strikes may involve roads.

Before the year winds itself up a vast amount of railway construction will have been done. The rush of capital southward continues, but much of it is invested for speculative purposes. A host of engineering enterprises are coming up all over the country and a host of petty requirements will be made to establish and equip manufacturing establishments of all kinds.

The East is somewhat jealous of the progress in these newer sections of the country and foresees the possibility of being ultimately deprived of a large slice of business it now enjoys, but for the present eastern and northern shops have a good stock of orders on hand, involving the manipulation of iron, steel and lumber. Lower traffic rates are probable on eastern as well as western lines. Elements of cost in all direction are likely to decline. An abundance of money will continue to stimulate manufacturing, mining, and shop and house building. Yet with all these favorable indications, there are secret whisperings "trim your sails." Despite this the sails are being trimmed for an increased producing capacity in all the great channels of trade and the captains are making no mistake.

The Piers of the Dufferin Bridge, India.

The piers of this bridge, recently opened to traffic, and by which the Oude & Rohilkund Railway crosses the river Ganges, are deserving of note by engineers. They are elliptical in shape, built of brick work and concrete and are sunk from 50 ft. to 140 ft. below low-water.

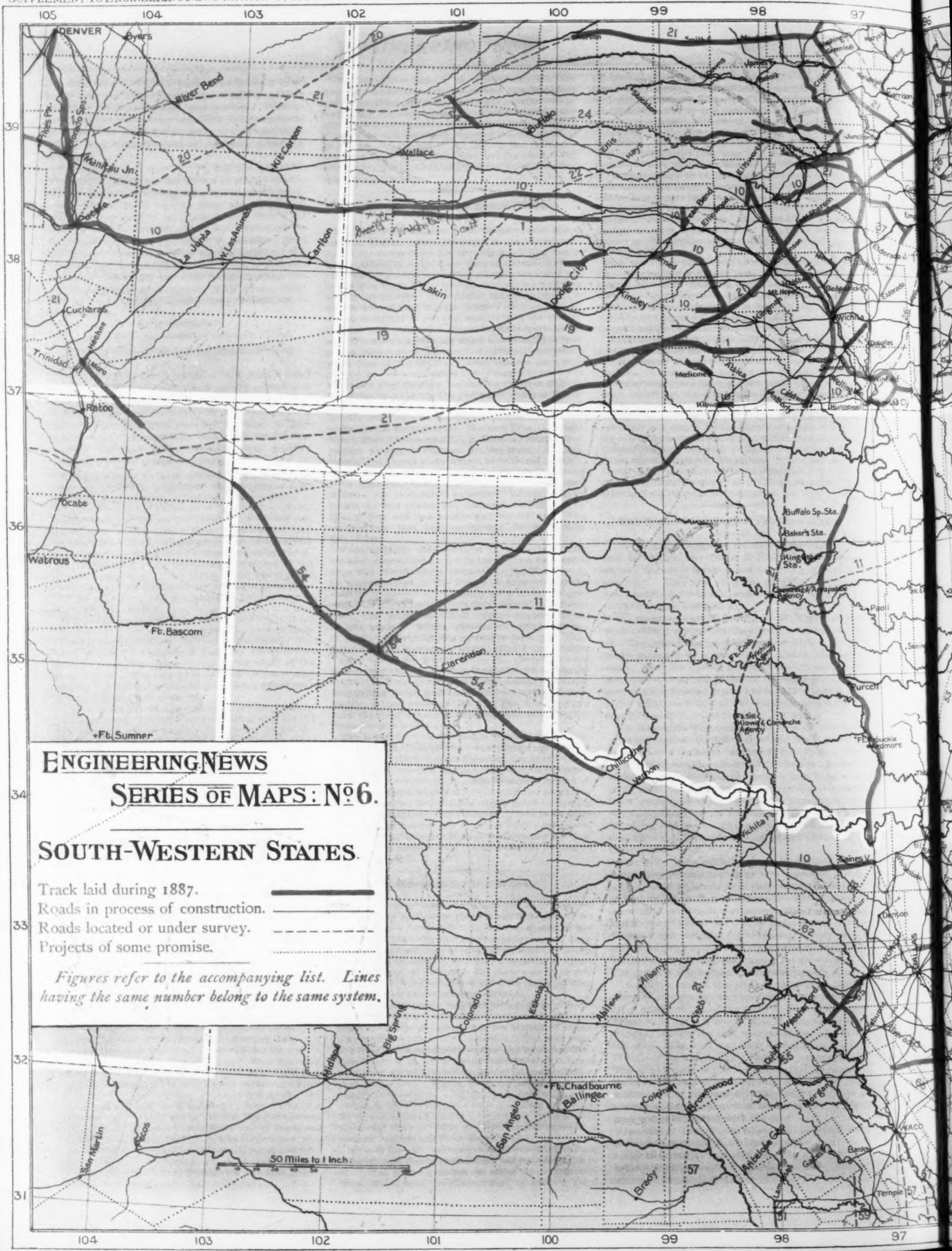
The main piers are 65 ft. long by 28 ft. wide at the river surface; above this they reduce to 60 ft. by 25 ft. The tops of the piers are capped with 8½ ft. of stone masonry at a point 72 ft. above low-water mark. Pier No. 5 is 251 ft. 4 in. from the bottom of the caisson to the top of the 356 ft. bridge span. The piers for the smaller spans are founded on two circular wells, each 12½ ft. in diameter and vary in depth from 25 ft. to 114 ft. below low-water.

The main piers were commenced in from 10 to 30 ft. of water, and on account of this they were started in wrought-iron caissons made of ⅝in. plate, connected and braced together and divided by two cross walls 5 ft. wide dividing the caisson into three compartments. This caisson was connected to the upper brick work by 24 angle bars, 3×3 ×⅝in., with horizontal binding rings of the same section every 8 ft. in height, and tied by cross bracing across the partition walls and strengthened by gusset plates. The shoe was cast-steel.

The wells were sunk by the aid of the Bruce & Batho digger, working from two pontoons (200 ft. long by 25 ft. wide and 10 ft. deep) fitted with cranes, guides and lowering machinery. Three diggers were used over each compartment and the cranes had a capacity of 20 tons. The diggers were 8 ft. in diameter and weighed 3¼ tons empty; they would each hold 110 cu. ft. The diggers were ordinarily worked at night, and the average progress was 2 ft. The greatest depth sunk in 12 hours was 6ft. 9 in.

In sinking one of the smaller piers in clay, with scarcely any water, an opportunity was presented for a practical test of the friction due to this clay. When built up to a height of 41 ft. 9 in. the sinking stopped, though the clay was excavated 4 ft. below the shoe. The well was then loaded with 499 tons 14 cwt. of rails and brick before it moved again. The total weight of pier and load was 2378 tons and the area of the pier in the ground was 154 ft. ×34 ft. = 5236, sq. ft.; consequently the weight required to overcome the friction was over 9 cwt. for each square foot in contact with the clay.

In sinking Pier No. 4, when the well had been built up 91 ft. with 70 ft. 6 in. below water, an unusual accident occurred. At this time the well was 50 ft. below the river bed, and sinking had been stopped with 9 ft. excavated below the curb. To break



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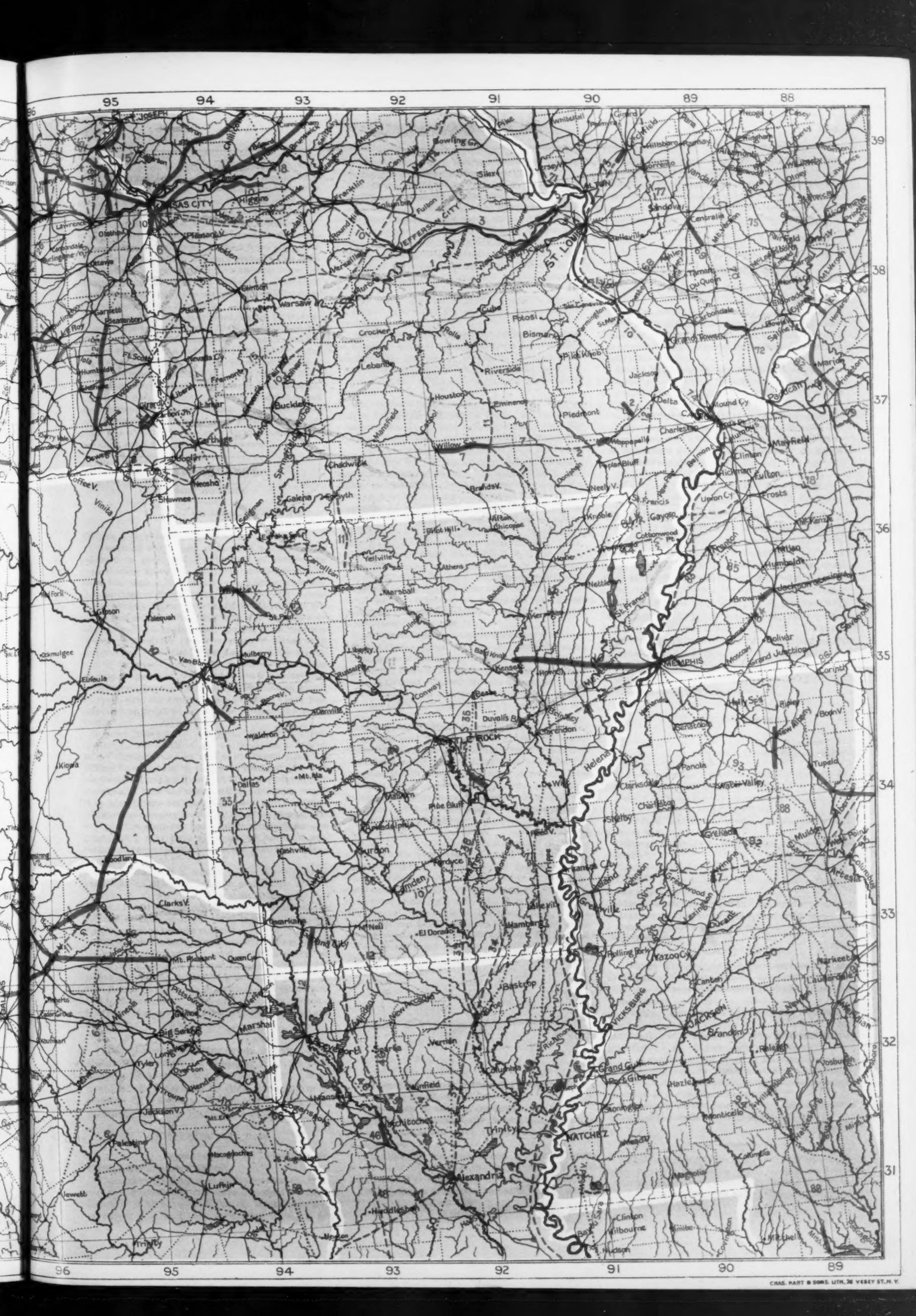
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Clarksville
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Monticello
Vicksburg
Jackson
Greenville
Greenwood
Yazoo City
Meridian
Tupelo
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Rock Island
Moline
Galesburg
Quincy
Hannibal
St. Joseph
Omaha
Council Bluffs
Sioux City
Des Moines
Cedar Rapids
Iowa City
Waterloo
Fort Dodge
Mason City
Minneapolis
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Redlands
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Tlaxcala
Pachuca
Tulancingo
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Matamoros
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Durango
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Oaxaca
Salina Cruz
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Tuxtla Gutiérrez
San Cristóbal de las Casas
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Campeche
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Progreso
Chetumal
Belize City
Belmopan
Flores
Tikal
Guatemala City
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Quetzaltenango
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Chichicastenango
Panajachel
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San José
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Limón
Puerto Limón
Liberia
Nicoya
Quepos
Golfito
Puerto Jiménez
Sierpe
Palmar Sur
Ciudad Neily
Paso Canoas
David
Chiriquí
Boquete
Volcán
Puerto Armuelles
Almirante
Bocas del Toro
Changuinola
Chiriquí Grande
Santiago
Chitré
Las Tablas
Pedasí
Los Santos
Penonomé
Aguadulce
Natá
Antón
Coclé
Colón
Portobelo
Panama City
Balboa
Miraflores Locks
Gatún Locks
Gatún Lake
Barro Colorado Island
Madden Lake
Madden Dam
Chagres River
Fort Sherman
Fort Davis
Fort Gulick
Fort Randolph
Fort Clayton
Fort Kobbe
Fort Amador
Fort Cimarron
Fort Espinar
Fort Lorenzo

through the crust of clay and boulders 16 ft. were added to the well and sinking was again commenced. When some 12 ft. or 15 ft. below the curb, the water suddenly rose above the top of the brick work, and with a loud report the brick work broke open at the upstream end, leaving a gap 4 ft. wide at water level. It is supposed that the primary cause of this accident was a sudden in-rush of sand from above the clay stratum on which the curb rested The sand displaced the water and brought a pressure upon the masonry which it could not withstand. The sand filled the cavity below the curb, and rose in the three compartments from 17 to 30 ft,

While the work was suspended, owing to this accident, a flood occurred and the displaced segment of masonry, including one-third of the circumference of the pier to a depth of 41½ft. below water level, disappeared. After many plans had been suggested for repairs, Mr. F. T. G. WALTON, the Resident Engineer, enclosed the pier in an iron envelope, inside and out, made of ¼in. plate and connected together and stiffened by bracing. This shell lapped over the sound brick work, and when lowered into place was filled with cement concrete, and the well was then sunk without further trouble.

CORRESPONDENCE.

Strains on Pins.

Washington University.
ST. LOUIS, Mo., Feb. 22, 1888.

EDITOR ENGINEERING NEWS:

Concerning the proper method of arranging the eye-bars on pins, and the method of computing the bending moments and fibre strains resulting from the same, I have nothing to add to my letter in your issue of February 4. In that letter I simply stated certain facts, the truth of which will be admitted by any one familiar with the elements of mechanics. An engineering journal is hardly the proper channel for the conveyance of elementary instruction. It is the proper means for the dispersion of improved methods, in practice or in analysis, but it should be presumed, when a new method is described, together with the principles on which its rests, that the reader whose practice lies in this direction is prepared to see the force of the statements.

In your issue of the 18th inst., Mr. A. S. COOPER challenges the truth of the propositions advanced in my former letter on this subject, and you, Mr. Editor, have put us on the same plane and invited me to defend my position. If Mr. COOPER will join my class in that subject, I will undertake to teach it to him to his entire satisfaction, but I respectfully protest against being called on to defend and explain the simplest mechanical propositions and principles I may have made use of, with the editorial inference that I have backed water if I fail to respond.

In this instance I would invite Mr. COOPER'S attention to the tabulated computation of Mr. FRANK C. OSBORNE in the same issue with his letter. If he does not admit the correctness of the method as there shown, I think it would be useless for me to try to set him right.

Neither do I admit that the fact that my propositions are "contrary to good bridge practice" is any valid argument against them. So much the worse for "good bridge practice" I should say. The fact is that bridge practice *in this particular* has been *wretchedly poor*, and it is only within a few years that pins have been properly analyzed and designed. Yours truly,

J. B. JOHNSON.

[No editorial inferences are in question, nor should the editors be assumed to have even attempted to go to the bottom of every communication presented to them, or to form an opinion in respect to its merits, unless they distinctly say so.—ED. ENG. NEWS.]

Fiber Strains in Pins.

NEW HAVEN, CONN., Feb. 20, 1888.

EDITOR ENGINEERING NEWS:

The undersigned has read with considerable interest the discussions that have appeared in recent issues of ENGINEERING NEWS, in relation to fibre stresses in pins, and begs permission to say a few words upon the subject, hoping thereby to help a little towards a clearer understanding thereof.

Prof. BURR, in his work "Stresses in Bridge and Roof Trusses," page 318, edition 1880, says, in a discussion on pin proportioning, "Let $2q$ equal the number of parallel bars in each panel, then there will be $2q$ couples; but half of them will tend to turn the joint in an opposite direction to the other half, consequently the total bending of the pin . . will be due to the sum of q couples, each of which has the force $w\,t\,T$ and lever arm t. Hence the bending moment is $M = q.\,w\,t\,T.\,t = q\,w\,t^2\,T$."

In the above equation, w is the width of bars, t their thickness and T the stress per square inch of section in the bars.

Prof. DU BOIS, in his treatise "Strains in Framed Structures," deduces a similar formula for the bending moment, but one in which no assumption is made as to uniformity of width and thickness of the bars on the pin. [Vide said work, page 308, edition 1883.]

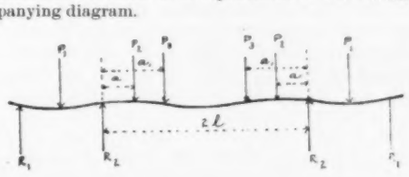
Prof. JOHNSON'S method is essentially the same as that of Prof. BURR and Prof. DU BOIS. Mr. OSBORN'S computations are made in accordance with this method. Mr. COOPER says the method is "contrary to good bridge practice," and furthermore erroneous. I believe that Mr. COOPER is right, and the formulas are fundamentally wrong. The authorities quoted agree in regarding, by implication at least, the stresses to which the pin is subjected as tending to curve the pin in one direction only; the pin is considered to be concave or convex its whole length. I can see no reason for believing that this is true, when there are more than three bars upon the pin. I conceive that the tendency is to bend or flex the pin in such a manner that the elastic curve will be concave and convex with reference to any plane perpendicular to the pull of the bars on the pin. The curve will have points of inflection or contra-flexure. In deducing the formula referred to above, this fact seems to have been disregarded.

If we assume that the stress in each bar is concentrated at the center of bearing, the resulting error will be on the side of safety. Making this assumption, the pin may then be regarded as a beam continuous over a number of supports (bars in one panel,) with a concentrated load in each span, (stresses in bars in the other panel.) The problem then becomes as follows:

Given an elastic beam continuous over a number of supports on a level, required to find the maximum bending stress therein under the application of a concentrated load in each or every span. In any case, the "Theorem of Three Moments" furnishes an exact solution for the problem in question. In most cases that occur in practice, it is sufficient to regard each span as a simple or independent girder and make the calculations accordingly; here again the error is on the side of safety. This is the method that Mr. COOPER would probably describe as in accordance with "good bridge practice," and so it is.

As a corollary to the view herein expressed as to the true nature of the problem involved, an insistence upon direct alternation in regard to the arrangement of the bars on the pin is in order,—a bar of one panel, then a bar of the other panel, then a bar of the first panel again, and so on. Any other arrangement is most likely to augment the stresses.

Taking the joint a as given by Mr. OSBORN, the elastic curve would be as represented in the accompanying diagram.



The bending moment at the point of application of P_2 would be $M = P_2\,a + P_3\,a_1 - M_1$.

M_1 being the moment at the support R_2.

M_1 cannot be numerically determined until the value of $2l$ is known. Mr. OSBORN'S data does not include this.

According to the data given by Mr. OSBORN, $a = 1''$, $a_1 = 2\frac{3}{4}''$, $P_2 = 30{,}250$ lbs., and $P_3 = 30{,}650$ lbs.; hence $M = 30{,}250 + 72{,}794 - M_1 = 103{,}044 - M_1$.

The maximum fibre stress would be

$$T = \frac{103{,}044 - M}{1.53} = 67{,}000 - \frac{M_1}{1.53}$$

$M_1 \div 1.53$ may be of considerable magnitude, hence T may be considerably less than 67,000 lbs.

If the bars were placed upon the pin in proper alternation in the example considered, the maximum fibre stress would be somewhat less than 30,000 lbs. per square inch,—an excessive stress, though not alarmingly so.

J. E. BUDDINGTON.

Definitions of Topography.

WASHINGTON, D. C., Feb. 14, 1888.

EDITOR ENGINEERING NEWS:

On page 873 Art. 1206, of the "Economical Theory of the Location of Railways," in the definition of topography, I am surprised to see Mr. Wellington straddle the fence.

I should like to see him make a stand and give to topography a meaning restricted to its present usage and not an antiquated Webster or Worcester definition.

On page 865 it is stated that "if a topographer be once properly instructed, and has a capable assistant, it is not at all difficult to take *a mile or two* of topography a day in ordinary country." It would be nearer to say, 8 or 10 miles.

Yours truly,
EUGENE RICKSECKER,
U. S. Geolog. Survey.

[Mr. WELLINGTON is disposed to reform a good many things, but he is not attempting to reform the English language to any large extent, nor to give to "topography" or any other word a larger or smaller meaning than Webster or Worcester give it without distinctly straddling the fence. Whether a topographer can take one or two or eight or ten miles of topography a day depend. chiefly on the kind of topography and kind of country. No topographer can take 8 or 10 miles of topography in country at all rough and have it worth anything afterwards for projecting location, although it may suffice to make a very pretty looking map. ED. ENG. NEWS.]

Titles of Engineers.

University of Alabama.
P. O. UNIVERSITY, Ala., Feb. 25, 1888.

EDITOR ENGINEERING NEWS:

In the hope that something definite may be attained I respectfully suggest:

Chief Engineer, head of department.

IN CONSTRUCTION.

Principal Assistant, having charge of two or more divisions.

Division Engineer, having charge of two or more sections.

Section Engineer, having charge of smallest subdivision in construction, to whom contractors are directly responsible.

Subordinates below section engineers are known as transitman, leveler, rodman, chainman, etc.

Chief of party of survey would be usually a division engineer.

ROADS IN OPERATION.

Resident Engineer, in charge of repairs, bridges, buildings and betterments of one road, it may or may not be part of a system of roads under one management.

Subordinate engineers, having charge of work of repairs, unless the resident, to be designated assistant engineers. Abolish the term residency in construction. Have only one chief engineer.

Large systems might prefer a chief engineer, head of the entire engineer department, and a chief engineer of construction, subordinate in some respects to the head of the engineer department.

Practically we are familiar with the evils of a loose and contradictory nomenclature.

ENGINEER.

THE Western rate war is not making much progress toward a settlement. The lines in the Southwest are being drawn into the fight, and it is feared that it will not be long before cuts will begin on the passenger tariffs.

ENGINEERING NEWS

TRIBUNE BUILDING, NEW YORK.

VOL. XIX., Saturday, March 3, 1888.

D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Kansas City, Mo.—Regular meeting, March 5. Secy., Kenneth Allen, 19 Deardorff Building.

Engineers' Club of St. Louis, Mo.—Regular meeting, March 7. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, March 7. Sec., John Bogart, 127 E. 23d St.

Western Society of Civil Engineers, Chicago.—Regular meeting, March 7. Secy., L. E. Cooley, 171 La Salle St.

Civil Engineers' Club of Cleveland, O.—Annual meeting, March 13. Secy., C. O. Arey, 31 Backstone Building.

Engineers' Club of Philadelphia, Pa.—Regular meeting, March 17. Secy., Howard Murphy, 1122 Girard St.

Boston Society of Civil Engineers, Boston, Mass.—Annual meeting, March 21, at Young's Hotel, 4 P. M. Dinner at 6 P. M. Secy., S. E. Tinkham, City Hall.

American Water-Works Association.—Annual meeting at Cleveland, O., Apr 1 17, 18, 19. Secy. J. H. Decker, Hannibal, Mo.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 280 Broadway, New York City.

Master Car Builder's Association.—Next convention at Alexandria Bay, N. Y; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reed, Waycross, Ga.

THE Legislature of Iowa and the Governor of that State have been unusually severe in their late dealings with railway corporations, and politicians in search of an issue are pushing bills which would still further increase the grip of the State upon "these monopolies." The most important of these bills propose to reduce railway fares to two cents per mile, and to elect the Railroad Commissioners by popular vote and clothe them with absolute arbitrary powers. This action was supposed to meet the high approval of the general public, and to be for the interest of that public—and the men who seek its votes. But a reaction has set in, and just now the legislators are somewhat bewildered. Labor organizations fear a reduction of wages and protest; commercial bodies kick at a threatened reduction of business, and railway employés vigorously petition from all quarters of the State; all asking to be saved from their friends. The lesson to be learned is that a State should not be too hasty in obeying mere popular clamor and the windy arguments of politicians; else, in unjustly squeezing large corporations, it may also find a very goodly number of its citizens most unmercifully pinched, and that by its own action solely.

IN connection with the matter which we have lately published on the effect of cold on iron and steel, the following paragraph, which we find in ENGINEERING NEWS of Feb. 25, 1882, will perhaps bear reprinting, although it lacks the vital element which other records give; the comparative frequency of fractures at various temperatures *all below freezing*; these records, as we have heretofore said, going far to disprove the common assumption that the winter and summer differences are to any great extent an effect of the difference in the condition of the road bed.

From observations made on Russian railways it appears that the frequency of fractures of steel rails rises as the temperature falls. The percentage of breakages having been found highest in March (18 per cent.), and lowest in June and August, (3 per cent.) The same condition has been observed to prevail on German railways in the case of ties. From figures published we learn that from Oct. 1, 1879, to March 31, 1880, 480 fractures of tires, or 18.9 per cent., occurred while the temperature was above zero (32° Fahr.); 105 fractures, or 4.1 per cent., at zero, and 1,952 fractures, or 77 per cent., at temperatures below zero. The greatest number of fractures happened on Dec. 9, 10, 17 and 23, 1879. Tires of fine-grained iron and puddled steel appear to be safer while ingot steel offers greater advantages as to wearing.

We cannot but look on the records of experiments on axles, which we have lately published, as among the best and most conclusive of all as to this question. Perhaps their most interesting feature was the extreme moderation of the ranges of temperature chosen, which was only from 7 to 10° Fahr. for the cold tests and 100° for the warm tests, or only 90° range, a modest one even for the English climate, and 30 to 50 per cent. less than the range of ours. Despite this modest range the effects shown were very great indeed, and we may reasonably suppose that with a greater range the contrasts would have been much stronger than they were. In one sense Mr. ANDREWS showed the true spirit of the experimenter in restricting himself to such a range, and it certainly tends to strengthen confidence in the reliability of the tests; yet in another sense, it would not only have been justifiable but decidedly preferable to have chosen wider extremes for comparison, since it is a recognized fact both in mathematics and in physics, that a resort to extreme cases is the surest way of determining truth or error. If anyone is at all interested in the question of the strength of metals (and what civil or mechanical engineer is not), we advise him to go back two weeks and read the article we refer to, and then explain the defects in the experiments which makes them inconclusive, if he sees any.

JUST now street car accidents are entirely too frequent, and the usual charge of the damaged pedestrian is either that the driver did not signal at all, or that his yell or whistle was mistaken for something else. In this connection the Paris system of signalling has certain advantages; there, attached to the rail in front of the driver is a strong circular bellows, with a stout spring inside and a thin brass bell-mouth projecting towards the front. The driver usually sits with his elbow on the bellows and a slight effort is productive of a series of vigorous toots that can hardly be mistaken for anything else in the way of street noises. The personality of the driver is eliminated—with decided advantage in most cases—and the volume of "squawk" can be easily adjusted to suit the emergency. Disagreeable as the sound might prove, it would be much less so than the remarks which too often now proceed from the front platform of a car.

THE Citizens Improvement Association of Montreal, is evidently doing a good work in stirring up the somewhat conservative authorities of that city to a broader and more lively appreciation of their duties of office. The latest move of this body is to recommend the appointment of a thoroughly competent sanitary engineer, or board of engineers, to make a searching investigation into the condition of the city and report upon the cause of the present abnormally high death rate. This engineering service is to be paid for by the citizens, and their letter to the city Board of Health asks the hearty coöperation and influence of that body in this practical attempt to assist the city authorities in measures looking to the general improvement of the city. From private but most competent sources we understand that this action has been forced upon the intelligent and more progressive citizens, by the most criminal disregard of all the laws of sanitation in many sections of the city, and by the apathy of a large class of citizens who in a measure control city legislation.

THE behavior of the Brotherhood of Locomotive Engineers has been so conservative in the past, and their affairs have been so ably managed, that in their present controversy with the Chicago, Burlington & Quincy Co. they will have the sympathy of very many who, as a rule, do not favor strikes and have little interest in common with labor organizations. We know little of the inwardness of the issue now taken, either from the stand point of the company or that of the engineers; but judging merely from the well known policy that has heretofore ruled this body of employés, who as a class are among the most intelligent and faithful of our working men, we should suppose that they had a real grievance and just cause for complaint. Their general behavior so far has been very creditable to themselves.

A NEW system of electric street car propulsion, claimed to have very material advantages over any now in use (which so far as we can gather it might easily have and yet be far from perfection) is approaching a trial in this city. It is controlled by the River and Rail Electric Light Co., of this city, and is different from any other system known to us in all four of the following details; first the storage battery, which is claimed not only to be far more durable than the others better known, but to give an electro-motive force of about 3 volts in place of 2, which is the ordinary limit, and to develop a horse-power an hour from about 80 lbs. of battery, or less; secondly, in the motor, which has an obvious advantage in one respect, that all the revolving parts are plain iron or steel bars, without any wire coils on them, and which is alleged to be more efficient electrically than any of the other types; thirdly, in the mechanical connection, by which the high speed of the motor is reduced and transmitted to the wheels; and fourthly, in the electrical connections with the batteries, by which the ordinary horse car driver is enabled to use the battery energy properly and equally. The mechanical connection we have examined in some detail, and it strikes us as a triumph of mechanical ingenuity directed to a most difficult problem which has heretofore been most inadequately solved; that of effecting a very great reduction of speed in a small space and with few and light parts, and providing also for stopping and starting smoothly and easily. It would be premature to enter into any full description of it, or the system generally, nor would it be possible to do so without drawings, but we shall be surprised if the plant as a whole does not come far nearer than any other has yet done to an entirely practicable system of street car propulsion, even if it doe ot fully reach that

point: for despite the hopeful talk of which we hear so much there is as yet nothing before the public in the way of electric street car propulsion which can be regarded as satisfactory for general use. The main features of the plant are all the invention of Prof. WM. MAIN, the electrician of the company, formerly of the University of South Carolina, and we earnestly hope they may prove as successful as they are ingenious.

WITH his letter in respect to the Student grade, which appeared last week, Mr. JAMES FORREST, Secretary, Inst. C. E., sent us an assortment of eight papers as samples of those which have been presented by Students in the past few years, and found worthy of publication. Every one of the papers appears to be up to the high standard of the Institution, and they are for the most part records of actual experience or experiments of the Students. They are all fully illustrated. The papers are:

Sennett on the Electric Light; pp. 25.
Brebner on Dioptric Apparatus in Lighthouses; pp 23.
Dawson on the Eastern Canal of France; pp. 29, full plates.
Goodman on Researches in Friction, 2 parts; pp 36 each; full plates: a masterly paper based on personal experience which we shall shortly republish in abstract.
Ransome on the Conversion of Timber by Circular and Band Saws.
Parsons on Centrifugal Pump.
Allen on Machine Tools.
Shaw on Small Motive Power.

All of these papers except one were awarded the Miller Scholarship, which pays $200 per year for three ears, and were read at Students' meetings'. The sole exception was a paper read at one of the ordinary meetings of Members. The Miller fund in all, which is devoted especially to Student prizes, pays $750 per year.

A "Kindergarten annex," which presents to a Society "primary education" in this fashion, may be borne with some equanimity, and makes the objections raised on that score seem somewhat silly; especially that considerable fraction of them which came from men who have not themselves been particularly conspicuous for their own contributions to engineering knowledge.

The Design of the Quaker Bridge Dam.

III.

Most engineers have had occasion at some time in their life to smile at the strange engineering mistakes which architects sometimes make; but they do not always so clearly realize that the engineer is in quite as much danger of unknowingly making architectural mistakes, as the architect is of mistakes in engineering. It has always seemed to us that the practice should be more general than it is of calling in good architectural advice as to the exterior form of engineering works of magnitude. For example, the Brooklyn bridge towers and approaches have been severely criticised by architects of prominence, and we apprehend with justice, as needlessly crude in design, compared with what could have been done with the same material at the same cost.

The same is true, it seems to us, of certain features of the proposed design for the Quaker Bridge dam, and we cannot look on this as the entirely unimportant matter that some may regard it. It is to be remembered that the dam is to stand for centuries, during which the city will be constantly growing toward it, and that it will for a long time to come be one of the sights of New York and of the world. Thousands of people weekly are likely to visit it, and it is surely desirable that, so far as is possible without increase of cost, it should be passed down to the future as in every detail a worthy monument of what New York could do in the days of its youth, when there was only one bridge across the East river and none across the North river. Especially is this true if the question of appearance involved is an appearance of weakness. The pride which New York has always had in the High Bridge is an evidence that this question is not in any case a light one, but any details of the design which would needlessly tend to encourage a fear that the dam was not strong enough, however unwarrantably, would be particularly unfortunate, and architecturally inadmissible.

Viewed in this way there are several details which seem to need attention. That a curved dam instead of a straight is immensely preferable in this respect, as more pleasing and satisfying to the eye, will hardly be denied. A straight dam will certainly *look*, as we think it is in fact, very much weaker. This is especially true if, as proposed, the upper part of the dam is made vertical. It seems to us, therefore, that this detail of the design should be modified.

Even in the engravings this verticality gives the upper part of the dam the appearance of overhanging. In the actual dam it seems quite certain, this effect will be intensified so as to give the whole top of the dam the *appearance* of being on the point of pitching headlong down the valley; for this reason: The eye is not accustomed to such enormous batter in masonry as the lower part will have; it will inevitably steepen it, and with it all the upper part. The eye will likewise better estimate the enormous pressure that the dam resists when looking at the actual water than when looking merely at the drawings. To have the upper 40 ft. *appear* vertical it should actually batter, it seems to us, fully 2 ins. per foot, and perhaps batter more.

Again, it is an axiom of architecture to avoid vague and unmeaning lines and angles. The back of the dam (see Fig. 1 of our issue of Jan. 7, and subsequently) is broken by three such lines and angles, just decided enough to readily catch the eye, and *not* decided enough to make it comprehensible to the eye (nor to the reason) why, when the surface came so near to it anyway, it was not given the grand sweeping curve which architectural beauty and mathematical theory alike demand. The reason given for adopting the angular form is a strange one indeed, it strikes us, viz.:

"The few sloping lines forming the outline of the profile, *which were adopted to facilitate construction*, follow closely the many sided polygonal figure (i. e. curve) which would be indicated by the successive calculations of a number of horizontal slices of the section."

This reason for deviating from theory in

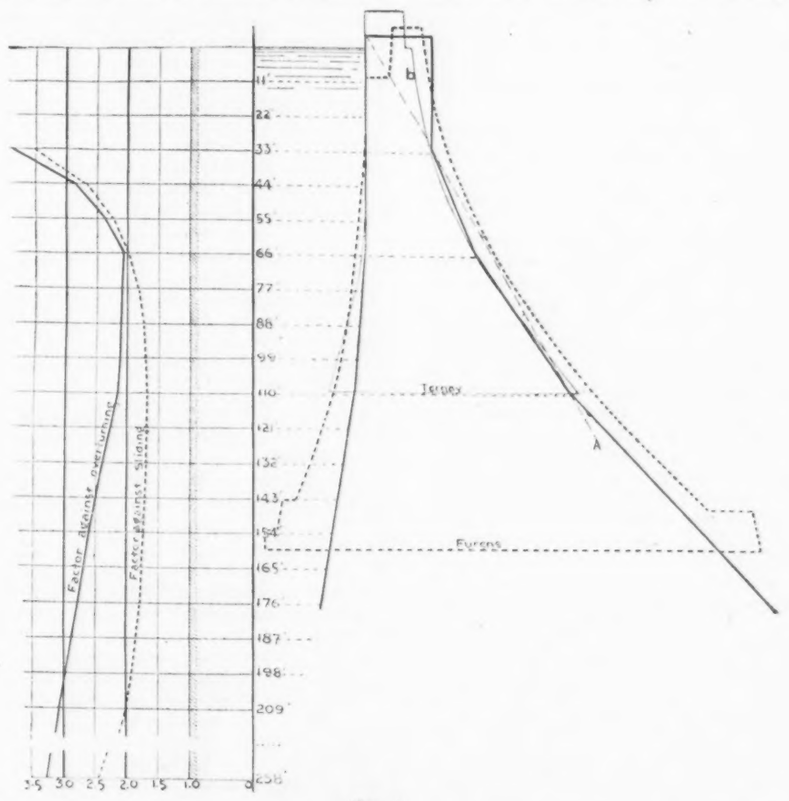


Fig. 1

order to substitute ugliness for beauty certainly strikes us as a rather absurd one, for we have no belief that there is a contractor in America who would make the difference of a $5 bill because of it in his total bid for 496,862 cu. yds. of masonry; meaning as it does simply that he would change his batter once a month or so instead of once a year. This being so, this is a rather marked example of a tendency which engineers of otherwise great ability too frequently show, to ignore entirely the element of beauty even when it costs nothing; and as such, is especially worthy of note.

Again; the dentillated arch cornice which caps the dam (an admirable detail adopted from the Furens) had in the first design of the Quaker bridge (Fig. 1) a constructive excuse for being, since the arches were used to widen out the top of the dam for a roadway without adding needlessly to the top mass. The arches were deeply recessed, the sweeping curve of the main face being continued up into them. In the revised design these recesses are so nearly filled with masonry that the arches become *merely* decorative, degrading this graceful feature to mere

"constructed ornament" instead of "ornamented construction," and hence destroying much of its value for merely decorative purposes; a sacrifice which is the more to be regretted because the dam, as we contend, is made weaker by the added mass, rather than stronger.

And here we touch upon what is really the gravest criticism of the adopted profile: We cannot but feel, *first*, that in the desire to save first cost the dam has been made unduly light, and *secondly*, that the weakness is very unnecessarily, and to a really dangerous extent confined to *one part* of the profile, which can hence be made stronger with the same material, by a different disposition of it, and at the same time do away with a still more objectionable tendency of which we shall speak, that, namely, to concentrate all elastic and vibratory action from temperature, wave action, water pressure, etc. at one point *and that the weakest point*, viz., 66 ft. below the water line, thus concentrating likewise the tendency to disintegration of the masonry joints at or near to one point.

As to the first point: Down to the level of 165 ft. (see right of Fig. 1) the profile is the weakest in the world. At its weakest point (66 ft.) the Ternay is a shade thinner, but the Ternay has not the objectionable concentration of elastic strains that we have mentioned. The Furens is the next weakest dam of importance, and its profile (no doubt amply strong), is shown in Fig. 1. Now as there is only *one* precedent for so thin a dam as this, why choose so vitally important and so unprecedentedly high a dam as this to sail a shade closer to the wind in than any one has ever dared to do before? No doubt engineering must advance, and it is in order to prove that the factor of safety is great enough nevertheless, but is a factor of 2.07, which is against still pressure only, and is diminished *pro rata* by whatever wave action there may be, a factor great enough to warrant an experiment? Doubtless it might be if the cost of a higher factor would be great, but in this case, to fill out the profile to the Furens profile down to about 130 ft. below the water line, thence connecting with the proposed profile, besides adding greatly to the beauty of the structure by wholly eliminating a top-heavy appearance, would increase the thickness at the most strained level (66 ft.) from 35.75 ft. to about 42 ft. or 16⅔ per cent., and the factor of safety at that point by something like one-third (there being the additional weight as well as the greater resisting moment due to the broader base), while the area of the profile is increased only by some 550 sq. ft. in 26,118, or hardly more than 2 per cent. Is it best to save 2 per cent. of material to cut down a *uniform* factor of 2½ to 2¾, as it is approximately in the Furens and first design of the Quaker bridge, to an *irregular* factor of 2.07 less wave action at one point only, and a greater one everywhere else? We cannot but feel that this is not only inadvisable but inadmissible. For symmetry and appearance of strength only, the additional mass should be used, for appearance alone is not to be despised. One of the ablest engineers of our acquaintance once said to us "I figure a structure as close as I can, but if it don't *look right* after I am through, *I make it look right*." With a trained and intelligent eye as a guide that is the soundest of sound practice.

To make these and one more point more intelligible, we have plotted at the back of the section, shown in Fig. 1, the actual factors of safety at each level, as given in the "Synopsis of Data," Adopted Profile (Table III.) published in our issue of Feb. 11, except that the line marked for conciseness "Factor against Sliding," is not strictly such a factor except for a co-efficient of friction = 1.00, but rather the number of times the weight of the superincumbent mass exceeds the horizontal thrust of the water. As any horizontal sliding is not likely to be in a horizontal plane, but on a ragged diagonal plane extending downward from the water front to the back, this co-efficient of friction (1.00) seems to us quite as high as can be counted on, if not too high, so that the resulting curved line may be safely termed the "Factor against Sliding."

The graphical result seems to us highly instructive. We need not point out to engineers that it is bad to have any structure under strain conspicuously weaker at one point than another. It becomes weaker and less durable than if all parts were weak alike, because the tendency to molecular disintegration concentrates itself at one point. Take a whip-handle. It will sustain great elastic or static strains for a long time. Enlarge the same stick into an hour-glass form, with the same section at the middle only and much heavier everywhere else, and it will break under far less strains in far less time. This rudely illustrates the nature of our objection to this design. For the permanent stability of such friable material as cement joints the lines of both factors of safety should be nearly vertical.

Railway Building in the Southwest.

The mileage of the new railway lines completed and under way in the Southwest, shown upon the map which we publish with this issue of ENGINEERING NEWS, is summarized in the following table:

States	Track laid 1886	Track laid 1887	In process of construction	Located and under survey	Projects of some promise
Mo.	79	556	436	1549	584
Kan.	1561	1889	335	830	557
Ind. Ter.	79	408	83	569	466
Ark.	61	138	48	1172	730
La.	9	62	70	867	815
Tex.	538	1005	282	703	2023
Total	2327	4058	1254	5690	5175

The mileage constructed during 1887 by the six principal systems of the Southwest was as follows:

System.	Total track-laying in above States	Total track-laying on entire system
Santa Fé	1178	1617
Mo. Pac.	795	991
C. R. I. & Pac.	656	816
St. L. & S. F.	281	281
Ft. Worth & Denver	262	312
St. L., Ark. & Tex.	229	229
Total	3431	4246

The above figures show very plainly the progress which the different States have made and are likely to make in the work of railway building, and also the interesting fact that over five-eighth of the new mileage of 1887 in these States was added to the three great Southwestern systems named above, while the work done by the three other companies named brings the total of work by the six corporations up to nearly seven-eighths of the whole. In no way can the location of the regions of active work be so clearly seen, as by reference to our map, where also the new lines belonging to each system may be traced. The region of most active work during the past year has been in a broad belt through central Kansas, almost the same region in fact where the construction was most active in 1886. Less work has been done in the eastern part of the State, however, and more in the northern and western part than in that year.

The State stands at the head in the construction record of the year of course, and its 1,900 miles of tracklaying is a far larger record than has ever before been achieved in any State in a single year. "Bleeding Kansas" has become a prosperous empire in the past decade, and the network of railway lines in the eastern half is now almost as close as in Illinois. The Western third of the State is still scantily supplied with railways; but it is yet a question whether that part of the State is not too subject to drought to support a very profitable agriculture; and investors in mortgages on farms or bonds of railway lines in this section must run considerable risk.

It will be noticed that in the above table the record of the mileage under construction, located and projected in Kansas is comparatively small. We are not at all ignorant of the existence of a great number of railway projects in the State. In fact, there are on our records something like 75 railway corporations which have filed charters in the State of Kansas within the last twelve months for about 50,000 miles of new railway lines. These visionary enterprises are for the most part organized to boom the real estate agents of some mushroom town; and though their promoters may hire some cheap compass manipulator to run a preliminary line or telegraph the news all over the country that they have set a dozen Italians at work shovelling dirt on the prairie, yet they are not properly railway enterprises and we do not intend to include them in our list. If any of our correspondents find among our list any schemes which they know to be of this class, we will be obliged if they will write us to that effect. But while we do not intend to include in our lists any of these sham enterprises, of course many of the projects in our list are still in embryo or moving but slowly for lack of sufficient backing. We include them because they are worth the attention of those interested in railway construction, and it would be manifestly incorrect to exclude an enterprise of real merit because of its newness or beaause it was temporarily at a standstill.

The above is especially true of many of the projects in the States of Missouri, Arkansas and Louisiana. The tracklaying in these States during last year was very small except for the two long lines through Northern Missouri; but there has been a great amount of surveying going on, and many new companies have been formed. It certainly seems that the proposed roads in these States have good prospects of profit. The lower Mississippi valley is as fertile as any region on the globe, and its rainfall contrasts strongly with the aridity of regions farther west. It is true that a great part of Arkansas and Louisiana is a heavily timbered swamp, and that the country must develop much more slowly than has been the caseon the treeless prairies of Kansas, but developed it certainly will be, and with the lowlands drained, and the uplands cleared, it will before many years be far more densely populated than now. This section of the South has only begun to feel the industrial awakening that has given Georgia and Alabama such a start ahead, but capitalists are beginning to examine its resources, the various cities of the region are getting ready to boom, and the present season is likely to see some of the many schemes of the last year put under way.

Turning to the belt farther west, the extent of tracklaying in Indian Territory is especially noticeable, and indicates something of the pressure which is constantly growing stronger toward opening to settlement this area of fertile land more than 65,000 square miles in extent. At present of course the new lines across it depend principally on through traffic for revenue; but it is probable that before many years there will be a net-work of railways through this region as thick as that in eastern Kansas. Texas nearly doubled its new mileage last year over the record for 1886.

The most important extension in the State and one of the most important of the year, is the long stretch of the Fort Worth & Denver up through the Texas Panhandle, across New Mexico, to a direct connection with Denver. This line is not only the first to open up a great section of the plains, but it will be an important through route, as it is the only line from Denver and the Rocky Mountain region to the Southwest. The gap in New Mexico upon this line, shown on the map as under construction, will be completed ready for trains by the time this reaches our readers. The backers of te Panhandle Route are by no means through with construction, and mean to add to their system, which now terminates at Fort Worth, a road to the Gulf. They have recently chartered a line to run in the same general direction as the Fort Worth & Denver to the State line, and presumably thence to New Orleans.

Equally prominent with the Fort Worth & Denver is the long line of the Missouri Pacific to Pueblo, Col., which has outstripped the Santa Fé's Great Bend extension. This is the farthest western point now reached by the GOULD system, but indications are not wanting that by lines "owned or controlled" it will not be many months in reaching the Pacific. The other work of the Missouri Pacific is plainly indicated upon the map, and it only remains to be said that just now for some unexplained reason the extension policy seems to have been suspended, and no one except Mr. GOULD himself seems to have any idea when it will be resumed.

The most important work of the Santa Fé after the Chicago extension, is the line due south across Indian Territory to a connection with the Gulf, Colorado & Santa Fé division, which gives these Texas lines an outlet to northern markets and connection with the rest of the system. The other Santa Fé line across Indian Territory and into the Texas Panhandle, is currently believed to be intended to reach El Paso, while either a branch from this or an extension of the line which now terminates at the Kansas State boundary is to go to Santa Fé or Albuquerque and form a cut-off to the present roundabout route to the Pacific coast through Colorado. The most important of the extensions of the Santa Fé during the coming season will probably be the St. Louis, Kansas City & Colorado lines across Missouri from Kansas City and Fort Scott. The southern line, as is readily seen, will be the most direct outlet to the North and East for the transcontinental line, the Texas lines, and, in fact, all of the system in southern Kansas. A line will also be built or purchased from St. Louis through Illinois to a connection with the Chicago, Santa Fé & California. Besides these extensions, under the name of the St. Louis, Kansas City & Colorado charters have been filed for a net-work of feeders and connections in Missouri, and there are some indications that the Santa Fé is behind some of the schemes in Arkansas and Louisiana. Of course, like every other company, the Santa Fé is dependent on the investing public and will have to whittle down its plans very materially if the rate war and the strikes frighten capital away from the stock and bond market.

The Rock Island's Chicago, Kansas & Nebraska system forms a prominent part of the work of the past year in Kansas. The company is evidently bound to contend with the Santa Fé and Gould lines for a large share of the traffic of the Southwest. The route of the line 300 miles in length, which is now being located to Colorado Springs is published for the first time upon our map, and will probably be the first work of the season. The company has made surveys through No Man's Land, and into New Mexico as shown, and also across Indian Territory, but these lines, as well as the extensive projects in Texas, only one of which is included upon our map, will be built as President CABLE says, "only as rapidly as circumstances will warrant."

The St. Louis & San Francisco system makes a creditable showing, and has planned a large amount of work for the present year, the most important of which is the extension across Indian Territory, and to Albuquerque, New Mexico. This is the old Atlantic & Pacific project which has been published on railway maps with a fine tooth comb addition since time immemorial. There seems to be a fair prospect now, however, that the line will be built. The Frisco's Arkansas projects which were pushed so actively during the early part of last season, seem to have been laid aside for the present.

The St. Louis, Arkansas & Texas has had a remarkable prosperity since its receivership was terminated and its gauge was altered to standard. Its work in the past year has been principally on extensions in northern Texas to Hillsboro, Fort Worth and Sherman. The lines now building to Little Rock and Shreveport will furnish it two other valuable feeders. The "Cotton Belt" still labors under a disadvantage in the lack of a northern outlet and it is likely that the managers will turn their attention soon to the work on the line from Malden to St. Louis crossing the Mississippi by a bridge at Grand Tower for which Congress granted a charter at the last session. The line has been surveyed and the plans for the bridge have made considerable progress.

Lack of space forbids further reference to the numerous schemes, surveys and completed lines of the minor companies. Their work is briefly summarized in the list, and has been recorded on the railroad news pages of our past issues more fully and correctly than in any other publication.

The Southwest led every other division of the country in railroad extension for the past year and it seems probable that it will maintain the lead for a number of years. It has by far the largest area of fertile country still deficient in transportation lines of any region of the United States; and while investors are slow to leave the grain fields of the Northwest for the cotton plantations of this region, capital is beginning to flow in this direction and will eventually receive an ample return.

New York Rapid Transit.

In connection with the late suggestions of Mayor HEWITT on the question of rapid transit lines constructed and controlled by the city; the board of Aldermen have presented to the Legislature a bill, or enabling act, which must first be passed.

This bill will apply to all cities of New York of one millions or more inhabitants. Under it the Commissioner of Public Works may submit to the Mayor plans, specifications and estimates for the construction, maintenance and operation of ways and means for the more rapid transportation of people, mails and freights by underground railway or otherwise. Plans are to be approved by the Mayor, Aldermen and Commonalty, and they may be changed or modified from time to time as the said authorities may deem necessary for the more efficient carrying out of the act. No plan can be adopted without first affording all persons interested an opportunity to be heard respecting such plans.

The bill enters fully into the methods of appraising and seizing land necessary and the remuneration of the previous owners. The entire purpose of this bill in fact is to enable the cities to make and adopt plans for a rapid transit road, to condemn and buy necessary property, and to borrow such sums of money as may be necessary to construct and operate these lines. The money is to be borrowed at a rate not exceeding 3 per cent., and the faith of the city is to be pledged for the payment thereof, and provision is to be made by a sinking fund for the redemption and payment of principal and interest of these bonds.

PERSONAL.

C. G. ELLIOTT, C. E., has changed his address from Tonica, Ill., to Gilman, Ill.

JAMES W. PIRSSON, of the firm of Hubert, Pirsson & Co., Architects, New York, died in this city last week.

Col. MANN, of the Mann Boudoir Car Co., New York, has retired from the company.

WM. LUSH, Chief Engineer of the St. Joseph & Grand Island R. R., has been appointed Acting General Manager, to succeed D. MCCOOL, General Manager, who has resigned.

H. A. PARKER has been appointed General Manager of the Chicago, Kansas & Nebraska Ry., to succeed C. W. FISHER, resigned; his headquarters will be at Topeka, Kan. E. ST. JOHN has been appointed Assistant General Manager, with headquarters at Chicago.

W. C. MODISETT has been appointed General Manager of the Chicago, Burlington & Quincy, Hannibal & St. Joseph, and St. Louis, Keokuk & Northwestern railways; he succeeds J. E. TEBBE, deceased.

J. S. JONES, of Ashland, Wis., Superintendent of the Northern division of the Milwaukee, Lake Shore & Western Ry., has resigned to accept the management of the western business of the Columbus & Hocking Coal Co. He will be succeeded by C. H. HARTLEY.

OTTO F. SONNE was one of the Assistant Engineers in the construction of the Sibley bridge, described in our issue of February 18, and not OTTO T. SOUNE, as there incorrectly given.

M. DOMINGO GARCIA Y CARTAYA, lately one of the chiefs of party on the Nicaragua Canal survey "met with an accidental death," in Nicaragua recently. He had just previously to his death resigned from the canal service owing to failing health.

THOMAS J. LONG, Mem. Am. Soc. C. E., late Engineer of the Morse Bridge Co., and formerly of the Dock Department of New York, has now opened an office in this city at No. 44 Broadway. Mr. LONG will furnish plans and estimates for and report upon proposed bridges, foundations, wharves, docks and engineering structures generally.

The Greenwich Ferry (England).

A somewhat peculiar ferry, or rather an approach to a ferry boat, has just been opened across the river Thames, at Greenwich, England. The boats themselves are 120 ft. long, 40 ft. wide and 6 ft. draught of water: they are operated by steam, and load broadside towards the landing.

The rise and fall of tide at this point is 20 ft. with a gradually sloping river bottom. To reach the ferry boat from the shore a moveable landing stage has been designed which may be described as follows: Upon a bed of concrete, 50 ft. wide and about 3 ft. deep is laid an inclined way 348 ft. long, sloping 1 in 10. On this are four tracks of 4 ft. 8½ in. gauge, and 11 ft. 3 in. c. to c. The rails used are of a "bridge" section, weigh 72 lbs. to the lin. yd., and are bolted to 6×6 in. wrought-iron transverse sleepers weighing 30 lbs. to the yard, and these are in turn bolted to 8×6 in. wrought-iron longitudinals.

On these tracks run two traveling platforms, rectangular in shape and 60 ft. long by 23 ft. 2 in. over all; the depth of the steel body is 2 ft. 7 in. and each weighs; unloaded, 125 tons. These platforms are parallel to each other, but may be operated independently. They are carried upon 24 18 in. steel wheels, under each, pivoted upon 4 bogies, with 8 wheels under each of the two forward bogies and 4 under each of the two in the rear. Should one of these platforms accidentally get off the rails it would float itself and 50 tons of load in addition.

The landing stage, which comes between the ferry boat and the two traveling platforms, is also built of mild steel, and is rectangular in shape; 70 ft. 2 in. long; 50 ft. wide, and has a depth over all of 7 ft. 8 in. This stage is carried on 32 steel wheels under pivoted bogies as for the platforms.

To operate the two platforms and the landing stage, a high pressure winding engine is stationed on each side of the river, with steel wire rope, 1⅛ in. in diameter, and winding drums 5 ft. in diameter. In connection with this part of the plant, two wells 10 ft. in diameter are being sunk 145 ft. below the

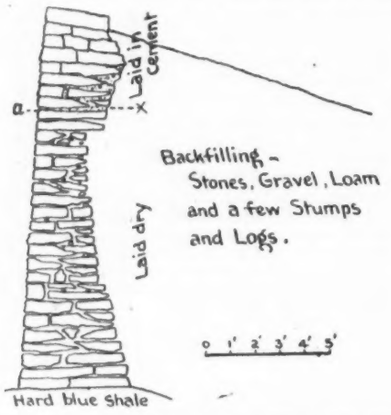
roadway on each side of the river. In these cylinders weights will be suspended acting as counter poises to the traveling platforms and stage. *Engineering*, from which we make this abstract, remarks that the contractor for these wells, "with fine old English crusted conservatism," is sinking the iron cylinders by the aid of divers, and adds "that it is at once evident that speed of sinking and cost are matters of comparatively small importance." To which we say—very evidently.

The Failure of the New Brunswick, N. J. Dam.

Mr. GEORGE HILL, City Surveyor of New Brunswick, N. J., sends us an interesting sketch and description of the dam across Lawrence brook which failed at 6.30 P. M. on Feb. 25.

This dam was located 2¼ miles east of the center of the city and impounded the water for the city supply; it stood in a narrow gorge on a ledge of hard blue shale of unknown character in all except that there is in this shale one large fissure. The pond is narrow but is 2¾ miles long. At the time of its failure the dam was 15 ft. high and about 225 ft. long, and had long been regarded as unsafe by the Superintendent of the water-works.

It is said that there has been a dam at this point since 1743; in any event the late dam was built 10 ft. high prior to 1800. In 1868 the Water Co. bought it and added 1 ft. to its height by the addition of large



coping stones; and in 1880 it was raised 4 ft. and capped with sandstone blocks, 2 ft. 6 in. by 8 in. by 12 in; laid in Portland cement. The face of dam was kept as tight as possible by plugging with cement.

The full width of the dam was used as an overflow in addition to flood gates in the southwest end, and the foot of the dam was protected by a 10 ft. apron of heavy plank. A height of 2 ft. of water on the crest has not been unusual in the past, though at the time of its failure there were about 7 in. upon it. The photographs sent with the account show the center third of the dam completely washed out, with vertical walls bounding each side of the break. There was considerable heavy ice in the brook at the time. As shown on the cross-section, the masonry below *a* was laid dry and that part above *a* in Portland cement as before mentioned. When the back filling washed out the cemented part fell towards the back of the dam.

Mr. HILL remarks that this cross-section is chiefly interesting as suggesting the query—"how did it stand so long?" Structures of this character seem sometimes to defy all engineering laws, as in the case of the approaches to a country bridge we know of, where walls 10 ft. high and 16 in. thick, of small

Prof. EGLESTON saw this process used at Essen some stone, have been supporting a heavy back filling of earth for at least 50 years.

Their preservation under these circumstances can only be ascribed to a special Providence or "force of habit" as one engineer put it.

THE Grand Jury of this city have been obliged to dismiss the indictment against JAY GOULD and RUSSELL SAGE for embezzling $3,000,000 of Kansas Pacific Bonds. Under the Statute of Limitations the indictment was barred, as over five years had elapsed since the date of the alleged crime.

PUBLICATIONS RECEIVED.

Telegraphic Communication between Fixed Stations and Moving Trains, under patents of Edison, Gilliland, Phelps and Smith. Consolidated Railway Telegraph Co., New York. Pamph., pp. 26.

A very interesting brief account of a system destined, we believe, to great extension, and very important practical use.

The paper on "*The Electric Motor and its Applications*," by the well known authority, FRANK L. POPE, which appears in the March number of *Scribner's Magazine*, contains a number of illustrations of the most recent examples of the application of electricity as a motive power, as well as drawings of the earliest experiments in this field, with a full page illustration representing Faraday showing his discovery of the principle of the electric motor to his wife on Christmas morning, 1821. In view of the recent advances in electrical science this paper will be of very great popular interest.

Sewage Treatment, Purification and Utilization. A practical manual for the use of Corporations, Local Boards, Medical Officers of Health, Inspectors of Nuisances, Chemists, Manufacturers, Riparian Owners Engineers and Rate payers. By J. W. SLATER, F. E. S., late editor of *Journal of Science*, etc. London, Whittaker & Co., and New York, D. Van Nostrand, Publishers, 1888. Size 5 × 7¼ in. pp. 270; illustrations; Price $2.25.

This is not only a practical but a very readable treatise on this subject, by an author who claims to have devoted 20 years to the study and treatment of sewage, from laboratory quantities to ten millions of gallons per day. The subject is broadly discussed from its nature under different conditions of location to its treatment and disposal by the multitude of known processes. Not one of the least valuable exhibits in this volume is a detailed list of the 450 or more patents issued with sewage treatment in view, given with a concise resume of the method of each patent. It is a very good book to have about the house.

SOCIETY PROCEEDINGS.

Engineer's Club of Philadelphia.—Record of regular meeting, Feb. 18th, 1888. Vice-President JOHN T. BOYD in the chair; 29 members and 2 visitors present. Prof. L. M. HAUPT presented, by title, the "Memoirs and Summary of Papers Relating to the Re-organization of National Public Works, Presented to the President of the United States, Nov. 11th, 1887; Compiled by the Executive Board of the Council of Engineering Societies on National Public Works." The Secretary presented, for Mr. W. H. RIDGWAY, an illustrated description of a "Direct-Acting Steam Crane." The Secretary presented, for Mr. FRED. H. ROBINSON, an account of the "Manufacture of Sewer Pipe by the Delaware Terra-Cotta Co."

Prof. L. M. HAUPT discussed the relative merits of salt glazing and slip glazing with Albany clay. There was a general discussion of pipe coatings of various kinds. Mr. HENRY G. MORRIS presented a paper under the title of "How Not to Do It:" in which he called attention to a case of careless construction in fitting up a system of hydraulic elevators. The sheaves carrying the hoisting ropes were properly put on top of a series of I-beams and made secure enough. But the sheaves carrying the counter-balance weights were suspended from the underside of these beams from a casting held by two ¾ in. stud-bolts, with the bolt holes drilled and tapped "in place."

Prof. L. M. HAUPT read some extracts from the Report of the Commission appointed by the State of New York to provide for the Internal Navigation of the State, dated Albany, March, 1812, and signed by GOV. MORRIS, S. V. RENSSELAER, DE WITT CLINTON, SIMEON DE WITT, W. NORTH, THOS. EDDY and ROBERT R. LIVINGSTON, and accompanied by the bill which was prepared for the National Legislature, providing for the construction of an extensive internal system of navigation to be executed by the several States and guaranteed by grants of the public lands.

HOWARD MURPHY,
Secretary and Treasurer

Western Society of Engineers.—The 244th regular meeting was held at the Society's hall, Chicago, Feb. 7; Mr. ARTINGSTALL, Chairman *pro tem.* The following were elected members: E. L. CORTHELL, Chicago; WM. T. CASGRAIN, Milwaukee, Wis.; CHAS. POORE, Chicago. L. E. COOLEY gave a resumé of a Brief upon the "Lakes and Gulf Waterway."

L. E. COOLEY, *Secretary.*

American Institute of Mining Engineers.—The 45th meeting and 17th Annual Meeting of this Society was held at Boston, the opening session being called to order by President THOS. EGLESTON at Hotel Brunswick, Feb. 21, at 8 P. M. The address of Welcome was given by Gen. F. A. WALKER, President of the Massachusetts Institute of Technology, who said the pleasant things usually expected. The city had not much of a technical character to show the members within their own lines of work, yet a busy city of thriving industries contained something of interest. Boston capital was not wholly consumed in building up the material city, or in its art and technical educational institutions. In conclusion he gave the Society a cordial welcome to the Institute of Technology which he represented.

President EGLESTON addressed the Society on the subject of educational methods. The old idea of education was that of cramming into a man all that he could hold. The new and true idea was that of drawing out of him what was in him by the harmonious development of all his faculties. Mere thought or mere facts in themselves have no value. It is the application of both which gives them value. The object now in technical schools was to educate the hand and eye and ear, as well as the brain, and for this purpose the best methods of both the German and French schools had been adopted in this country. He advocated the education of the hand simultaneously with that of the brain, which would, he thought, avoid nine-tenths of the labor troubles.

A paper on "Spirally Welded Tubing" was then read by Mr. J. C. BAYLES, who described the machinery and process of a new industry, that of the manufacture of pipes to carry pressures from strips of metal, spirally wound. The raw material used is the ordinary sheet iron of commerce. The lightest iron used was No. 29, although No. 22 will be the lightest used in practice, for pipe. From this thickness of iron different ones had been used up to steel gauges 12 to 14. The first process is to split the sheets into bands, which is done by an appropriate machine. The pipe machine is provided with a pipe mould but has no mandrel and occupies but 3×4 ft. floor space. Two strips are fed, the upper one being curved and the lower one flat. Gas flame is used for welding; no preparation of the iron edges being necessary. The hammer strikes 160 blows per minute. Six of these machines have been built thus far, which will manufacture pipe from 6 to 14 ins. in diameter. Others to be built will have a capacity up to 30-in. pipe. The spiral weld is a reinforcement, not a weakening of the material of the pipe; in every case of experiment the pipe has ruptured through the material and not through the weld, which is perfect. Steel is less successful than iron. 6-in. pipe of No. 14 iron has an ultimate strength of 1,800 lbs. per sq. in.; 12-in. pipe 691 lbs., ultimate. The manufacture is sufficiently economical to compete with ordinary pipe at market prices. This pipe is used chiefly in short lengths for cylinders in mills, being of a more perfect form than ordinary pipe.

Mr. H. M. HOWE described another method of making spirally welded pipe, employed by the Providence Steam Engine Co., with two ribbons which lay over a mandrel, the ribbons overlapping for half their width so that the pipe consists of two thicknesses. These are not welded but soldered together by means of a bath into which the mandrel dips as it revolves, thus putting a thin coating of solder on the strips which are at once soldered together by the pressure of the winding.

Mr. C. E. EMERY had investigated the soldered pipe and thought it superior for such uses as that of gun-barrels, while that made by the methods described by Mr. BAYLES could come into the market in competition with ordinary pipe. The original idea was the invention of JOHN B. ROOT.

Mr. J. F. HOLLOWAY spoke of a New York establishment for making welded, riveteless, corrugated boiler-shells. Thicknesses up to ¾ in. had been successfully welded. The Strong locomotive was a recent example, which makes the process now a commercial success, four years ago, and at Greenpoint two years ago.

The Secretary, Dr. RAYMOND, next read an entertaining paper on "New York Mining Law" reading a section of law still in force, by which all mines discovered or worked in that State, containing auriferous or argentiferous ore of certain limiting proportions became the property of the State. This law he traced back as a survival of old English law, which gave the King control of the precious metals and this, he said, had not done any harm, during its two hundred years existence to the present time, although of no conceivable use; in the language of the Darwinian theory, he should call it an "indifferent survival."

Notices and invitations to visit different points of interest were read by the Secretary, and supper served.

At the morning session at the Institute of Technology, Feb. 22, papers relating to Geology and Mining Engineering were read. A system of Geological Maps were explained by Mr. [illegible]VES. The different geological periods and formation[illegible] of the earth's crust were superimposed one over another, as they occur in nature, by a series of maps having sections removed, the object being to use them in teaching the principles of geology. Major HOTCHKISS thought profile sections should be added.

A paper was then read on the "Togography and Geology of the Cerro de Pasco, Peru," by A. D. HODGES, Jr., of Boston.

The next paper was on "Systems of Mining in Large Bodies of Soft Ore," by R. P. ROTHWELL, of New York, who spoke of the iron ores of the Lake Superior District. Ordinary timbering costs 40 to 60 cts. per ton of ore extracted. The system of sinking shafts in footwalls following the dip of the vein, with cross-cuts to vein, every 50 or 100 ft., was described, and the dangers of the vein slipping or bottom and top of cross-cuts sinking, illustrated. It was proposed to mine from the top instead of from the bottom by a slope system. The advantages were no dead work, except the shaft and the avoidance of caving, while all the ore in the vein was extracted. The paper was discussed by Dr. RAYMOND and Mr. FIRMSTONE.

For the next paper Mr. ROTHWELL exhibited a specimen of Scotch coal which was said to have the structure of radiated limonite.

The following paper was on "The Formation of Fissure-Veins," and the structural nature of ore deposits, by S. F. EMMONS, of Washington, D. C. He stated that these deposits were of aqueous, not eruptive, origin. Under the influence of heat and pressure water will take these metals into solution and redeposit them in cracks in the country rock, caused by faults, producing ore veins. Chemical qualities also play an important part. Sheeting of country rock in faults are made by sedimentary deposits. Mines are always on fault planes. In other places the ore is crushed matter which has replaced porphyry or sandstone veins.

The next paper was on "Recent Mine Accidents," by C. A. ASHBURNER, of Pittsburg, who gave the latest results obtained by a Royal Commission in England. Sir AUGUSTUS ABEL, one of the Members of this Commission, has investigated particularly explosions of marsh gas. Accidents are grouped as those caused by 1, explosions of marsh gas; 2, by falling rock roofs and coal; 3 miscellaneous, machinery accidents, falls down shafts, etc. Average results of over ten years in Penna., which produces about 60 per cent. of the entire coal product of the United States, and of which the anthracite is the more hazardous region, the statistics are: falls of roofs 29 per cent.; falls of coals, 22 per cent.; killed by marsh gas, 5; suffocation, 4; accidents in shafts, 3; blasting, 9; caught by machinery 8 per cent. The smaller percentage of roof falls in the anthracite region as compared with the bituminous region of English mines speaks well for the engineering skill employed there.

Mr. ECKLEY B. COXE, of Drifton, Pa., thought that mine accidents should be given in percentage of production, or in such way as to show when good work is done in these mines; also to avoid statistics that would indicate good work in one respect, while neglecting others.

Mr. ASHBURNER found that accidents go in cycles. Vigilance is a result of accidents, so that comparative freedom from them exists for some time after a great accident. He advocated more effective mining laws in order to diminish carelessness.

TO BE CONTINUED.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 146).

Phœnix, Ariz.—The works were commenced Jan. 1, 1887, and are to be completed by May 1, 1888; about two-thirds of the work is done at present. W. T. HUTCHINSON is Constructing Engineer. The contractors for material are H. P. Gregory and W. T. Garrat, of San Francisco. There is a Blake steam pump, with a 4-in. suction and a daily capacity of 250,000 galls., which pumps water from wells to a stand-pipe 150 ft. high, and a tank 60 ft. high. The day supply is pumped to the tank, which has a capacity of 20,000 galls. and rests on 3 brick piers 2 ft. wide and 24 ft. long; the night supply is obtained from the stand-pipe. There is a 40 H. P. boiler. Cast-iron mains are used and enameled iron for services. There are 5 miles of 5-in. mains, 300 taps and 18 fire hydrants. Ordinary pressure, 80 lbs.; fire pressure, 150 lbs. Average daily consumption, 50,000 galls.; there are about 800 consumers and 50 in the city offices. The cost of the works will be $25,000; debt, $5,000; rate of interest 12% per annum. The franchise is for 50 years; average rent, $3. The works are owned by J. J. Gardiner & Son; President, J. J. GARDINER; Secretary and Superintendent, J. M. GARDINER; capital stock about $20,000. The present population is estimated at 5,000.

Canisteo, N. Y.—The works were commenced July 9, 1887, and accepted Dec. 26, 1887. They were designed by GEO. R. HARLOW, who was also Constructing Engineer. They were built by James H. Harlow & Co., of Pittsburg, Pa.; the pipe was purchased from the Sayre Pipe Foundry, Sayre, Pa.; Eddy valves and Mathews hydrants are used. The supply is by gravity, the collecting reservoir being 170 ft. above the town. The village gives $15,000 and has the use of water through 50 hydrants for 30 years. All hydrants over this number are at an annual rental of $10 each. The franchise is owned by the Canisteo Water Works Co.; President, O. O. LAINE; Secretary and Treasurer, GEO. R. HARLOW. The present population is estimated at 3,000.

CONSTRUCTION NEWS.

RAILROADS

We give up this week most of our space usually devoted to Railroad News to the summary of work in the Southwest.

East of Chicago.

Existing Roads

Cooperstown & Susquehanna.—The directors have voted to build the four-mile extension to connect with the Ulster & Delaware's new line now under construction.

New York & Massachusetts.—An application has been made to have the Attorney General of the State of New York bring suit to annul the charter of this company. The line is the direct eastern outlet from the Poughkeepsie bridge and will be very valuable when that structure is completed. The syndicate who are building the bridge have not been able to buy the line on such terms as they desired and have tried many games of bluff to induce the owners to come to their terms. This last move will probably fail as the others have done.

Dayton, Fort Wayne & Chicago.—This company has been finally placed in a receiver's hands.

New Projects and Surveys.

Evansville, Suburban & Newburgh.—

EVANSVILLE, Ind., Feb. 24, 1888.

EDITOR ENGINEERING NEWS:

This line is to run from Evansville to Newburgh, Ind., a distance of about 12 miles. Work and grades are very light. Right of way is partly secured and surveys will be made in the next 60 days. Contracts may be let by June 1. LEE HOWELL, of Evansville, is President.

W. J. WOOD, *General Manager.*

Karshner, Washington & Chicago.—

WASHINGTON, C. H., Ohio, Feb. 27, 1888.

EDITOR ENGINEERING NEWS:

This road is to run from Washington *via* Clarksburg, Kingston, Adelphi and Cutler to Marietta, about 128 miles. The line will run through a fine farming country, through the heart of rocking coal, coke, iron and timber fields. W. P. CUTLER, Marietta, O., is President and JOHN KARSHNER, of Adelphi, is Vice President. Right of way is being secured and enough aid can probably be secured besides to pay well for the trouble. The matter of surveys is under construction and also the obtaining of capital. Recently Marietta wishes to join the enterprise and the name may be changed to Washington, Karshner & Marietta.

FRANK JOHNSON.

SOUTHERN.

Existing Roads.

Central R. R. of Georgia.—The headings on the Coosa Mountain Tunnel on the Columbus & Western Ry., met at 11 P. M. on Feb. 23. The tunnel is 2,420 ft. long.

Carolina, Knoxville & Western.—Hon. W. L. MAULDIN has resigned the Presidency of this company on the ground that the contract made with the construction company did not protect the interests of the people along the line, and left the President with so little power that he declined to be responsible for the company's acts, over which he had no real control.

New Projects and Surveys.

Kentucky Midland.—Surveys are nearly completed from Frankfort to the eastern line of Bath Co., the present terminus of the line, about 83 miles. Contracts are now being let for building this portion of the line. WM. LINDSAY of Frankfort is President.

Berkeley Springs & Potomac.—This company which has been formed to secure the building of a railroad from the Baltimore & Ohio line to Berkeley Springs, W. Va., has elected B. F. DEFORD of Baltimore, President.

Mississippi & Gulf.—This company has been chartered in Mississippi to build a line from Natchez to some point on the Gulf.

THE NORTHWEST.

Existing Roads.

St. Paul, Minneapolis & Manitoba.—President HILL's recent circular letter to the stockholders states that the completion of tracklaying on the Wilmar & Sioux Falls and Duluth, Watertown & Pacific lines, about 225 miles, with the construction of about 60 miles of local branches will leave the system so completed and consolidated that for some time to come no considerable extension need be undertaken. Should this be carried into effect, Bismarck and other Dakota towns which have been expecting the Manitoba will be rather disappointed. The Duluth extension is announced on good authority to be under contract and the Sioux Falls and Yankton survey is just completed. The press dispatch stating that the company has bought the Minneapolis & Pacific has probably no foundation.

Wisconsin Central.—The Abbotsford, Wausau & Merrill road, shown on our Map of the Northwest, will be built by this company this season. The line is 68 miles in length and $1,500,000 of securities will be issued on which the company's stockholders have the first option.

New Projects and Surveys.

St. Paul New Ulm & Southwestern.—This company has been organized in Minnesota to build a railroad from Hopkins *via* Chaska, Carver and New Ulm to Omaha W. C. BREDENHAGEN of Caver, Minn., is President, W. S. TIMBERLAKE of St. Paul is Treasurer.

Northern Minnesota.—This company has been chartered in Minnesota to build a railway from Emerson on the International boundary, south. GEO. THOMPSON, WM. F. KELSO and others of Hallock, Minn., are the incorporators.

Quincy Belt.—This company has been organized at Quincy, Ill., JOHN DICKS is President and JOHN M. SAVIN, Treasurer.

THE SOUTHWEST.

Existing Roads.

San Antonio & Aransas Pass.—This company is to begin work at once on the Houston extension, and right of way and subsidies are being secured for a line from Yoakums to New Braunfels.

St. Louis, Arkansas & Texas.—A survey is reported in progress from Llano, Tex., to Gatesville. Tracklaying is making rapid progress on the Little Rock & Eastern line in Arkansas.

New Projects and Surveys.

Gainesville & Southwestern.—This company has just completed its organization. J. M. LINDSEY, of Gainesville, is President, and JOHN T. WALKER is Secretary and Treasurer. The sum of $47,000 has been subscribed to the stock. It is now proposed to extend the line to Weatherford.

Chicago, Kansas City & Omaha.—The charter for this company has been filed in Kansas. The company is to bridge the Missouri river at some point north of the junction of the Kaw and south of Parkville. The directors are WALTER BROWN, of Kansas City; PHILIP L. SPOONER, of Madison, Wis.; A. WILLIAMS, of Topeka and others. It is currently reported that this company is to build a railroad across Missouri, utilizing the old Parkville & Grand River grade, and will cross the Mississippi at Oquawka and buy or construct a direct line to Chicago.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Chicago, Rock Island & Pacific.—The favorite occupation of the railway romancers of the West is to predict what this company will do. Within the past few days they have made it absorb the Atlantic & Pacific, the St. Louis & San Francisco, Denver & Rio Grande, Fort Worth & Denver and St. Joseph & Grand Island. What possible reason there can be for publishing these fictions of an imaginative brain, passes comprehension. What the Rock Island system has done and *may do* is pretty well shown upon our map. President CABLE is reported to have said that the company will build the 300 miles extension to Colorado this year and what other extensions good judgment may warrant. From the status of railway affairs in the West at this writing good judgment will warrant but very little extension.

Carson & Colorado.—The extension of 110 miles from Keeler to Mojave, Cal., seems to be very probable. D. O. MILLS of New York City is now the principal owner of this road, and is reported to have acknowledged his intention to build the extension.

San Francisco, Clear Lake & Humboldt.—About 25 miles have been graded on this California road, and it is likely that work will be pushed rapidly this season. W. H. PETTIBONE of San Francisco is General Manager.

New Projects and Surveys.

Rio Grande & Utah.—

Rialto Building, CHICAGO, Ill., Feb. 27, 1888.

EDITOR ENGINEERING NEWS:

The line of the Rio Grande & Utah Railway, has just been surveyed from Algodones, N. M., to Durango and Rico, Col., about 300 miles. The maximum grade is 80 ft. per mile. Right of way is secured, capital for building is partly secured, and it is expected to let contracts this spring. No Chief Engineer has been appointed. V. D. SIMAR has been the locating engineer.

JNO. W. CONLEY, *President.*

Golden & Denver.—

GOLDEN, *Jefferson Co.*, Col., Feb. 25, 1888.

EDITOR ENGINEERING NEWS:

The Golden & Denver Railway has been located from Golden to Denver, and thence leaving Denver on the North side and returning by South mines, a total dis-

tance of 30 miles. The work is light. The maximum grade is 70 ft. per mile. The only bridge will be one 1,200ft. long over the Platte river. The line is projected in the interest of property holders at the termini and along the line. The estimates, etc., will be complete ready for the letting of contracts by April. JOHN C. HODGES, Jr., is President.

EDWARD L. BEETHOUD, *Chief Engineer.*

Pueblo, Gunnison & Pacific.—This company whose contemplated organization was reported two weeks ago, has filed its charter to build a railroad from Pueblo southwest *via* the San Luis valley to Gunnison, thence northwest to the State line, with branches to Ouray, Lake City, and Pagosa Springs. The office of the company is to be at Pueblo. The incorporators are DAVID KELSO, H. R. HOLBROOK and others of Pueblo, Col., and JOHN A. GRAY of Lewiston, Ill. Mr. KELSO has been identified with Missouri Pacific schemes in the past, but it is probable that the enterprise will stand upon its own feet for a while at least.

Statistics of Railway Construction.

SOUTHWESTERN STATES.

Accompanying Map No 6 of the Progress and Prospects of Construction.

In the following list, "Track laid" is during the calendar year 1887. "Projected" as in former lists includes only those lines not yet located, which from all the information furnished us seem to have some probability of construction. Other terms explain themselves. For officers of old roads in the following list, reference should be made to Poor's Directory. The *numbers* given to each road correspond to those upon the map, and lines of the same system are given the same number. Otherwise the numbers are arranged in order, to facilitate reference from the map to the list. The list given for Illinois and the states following, includes ofcourse only the portions of the states included within the limits of the map and therefore is not summarized.

Our thanks are extended to the officers of the various roads who have furnished us the information from which the map and list has been prepared; and notice of errors in its compilation and further information of the progress of the enterprises under way is especially requested.

MISSOURI.

Existing Roads.

1. ***Atchison, Topeka & Santa Fé.***—Track laid, St. Joseph & Santa Fé R. R., Atchison, Kan., to St. Joseph, 20.4 miles—Chicago, Santa Fé & California R. R., Kansas City to Ft. Madison, Ia., 226 miles—St. Louis Kansas City & Colorado R. R., Valley Forge to Union, 36.1 miles; located—St. Louis, Kansas City & Colorado R. R., Union *via* Versailles to Kansas City, 238.7 miles, also Versailles *via* Clinton to Ft. Scott, Kan., 115 miles; surveyed—Chicago, Santa Fé & California R. R., Edina branch, 6 miles; projected, Independence branch, 4 miles.

2. ***Cape Girardeau & Southwestern.***—Track laid, Brownwood & Northwestern R. R., Brownwood to Bollinger's Mills, 9 miles, main line, Wappapello to Wellsdale, 4 miles; under survey, Wellsdale to Lee, 30 miles.

3. ***Central Missouri.***—Track laid, St. Charles, west, 10 miles; Graded, end of track west, 10 miles, and under contract to Fayette, 100 miles. Located to Kansas City, to Alton and to St. Louis, 170 miles. Chief Engineer and General Manager, J. T. K. Hayward, 518 Roe Building, St. Louis, Mo.

4. ***Chicago, Milwaukee & St. Paul.***—Track laid, Iowa State line to Kansas City, 140 miles.

5. ***Chicago, St. Paul & Kansas City.***—Track laid, Iowa State line, southwest, 46 miles; under construction, end of track to St. Joseph; 19 miles (Track now laid within 6 miles of St. Joseph) under survey, St. Joseph to Leavenworth, Kan., 35 miles.

6. ***Kansas City & Southern.***—Under construction, Kansas City to East Lynne, 48 miles, Kansas City to Hart's Grove, 11 miles. Chief Engineer, B. R. Whitney, Kansas City, Mo.

7. ***Kansas City, Fort Scott & Gulf.***—Track laid, Current River Ry. Willow Springs east, 35 miles. Under construction, to Grandin, Carter Co., 51 miles. Surveyed, Min len to Carthage, 30 miles.

8. ***Kansas City, Ft. Smith & Southern.***—Graded, Neosho, south, 30 miles; surveyed, Neosho to Carthage, 20 miles; projected to Ft. Smith, Ark., 150 miles. General Manager, M. W. Clay, Neosho, Mo.

9. ***Kansas City, Independence & Lee's Summit.***—Surveyed, Kansas City to Lee's Summit, 18 miles. The line will be built this season. Chief Engineer, Wm. B. Knight Kansas City, Mo.

10. ***Missouri Pacific.*** -- Track laid—Jeffersonville, Boonville & Lexington, Ry., between Lexington and Boonville, 27 miles—Kansas City & Southwestern Ry., between Kansas City, and Paola, Kan., 14 miles,—St. Louis, Oak Hill & Carondelet Ry. Tower Grove to Carondelet, double track for 6.3 miles, total, 12.6 miles; under construction—Jefferson, Boonville & Lexington Ry., end of track to Booneville, 50 miles; located—Mississippi River Ry., Bushberg, to Cape Girardeau, 100 miles; surveyed—Jefferson City & Southwestern Ry., Bagnell to Carthage, 150 miles. J. B. & L. Ry. Jeff. City to Boonville, 41 miles.

11. ***St. Louis & San Francisco.***—Track laid—Springfield Belt line, 3 miles; surveyed, Salem to West Plains and branch to State line, 173 miles, also Chadwick to Lead Hill, Ark., 48 miles.

12. ***St. Louis, Arkansas & Texas.***—Surveyed, Malden to Grand Tower, 88 miles.

New Projects and Surveys.

13. ***Chicago, Fort Scott & Texas.***—Projected, Higginsville to Ft. Scott, Kan. 100 miles. President A. H. Harris, Ft. Scott, Kan. Chief Engineer, R. E. Lee, Ft. Scott, Kan.

14. ***Chicago, Hannibal & Springfield.***—Under survey, Hannibal to Springfield, 235 miles. President, Roland C. Nickerson, Chicago, Ill.

15. ***Chicago, Jefferson City, Girard & Pacific.***—Projected, Jefferson City to Girard, Kan. 275 miles. President, W. F. Higgie, Girard, Kan. Chief Engineer. W. B. Gaw, Girard, Kan.

16. ***Memphis, Kansas & Western.***—Surveyed, Cherryvale, Kan., to Neosho, Mo., 80 miles. President, A. C. Kirby, St. Louis, Mo. General Manager, C. L. Berry, Cherryvale, Kan.

17. ***Kansas City & Sabine Pass.***—Under contract, Kansas City to Pierce City, 117 miles. Under survey Pierce City to Fort Smith, Ark., 120 miles. President, Harrison M. James, 31 Broadway, New York. Chief Engineer, J. W. Nier, Hall Building, Kansas City, Mo.

18. ***Missouri Midland & Bridge Co.***—Projected Chillicothe to Sedalia, Mo., 125 miles. President, D. C Basey, Brunswick, Mo.

Total.—Track laid, 556 miles. In process of construction, 436 miles. Surveys, 1,549 miles. Projects, 584 miles

KANSAS.

Existing Roads.

19. ***Arkansas, Kansas & Colorado.***—Track laid Dodge City to Bucklin, 26.5 miles; under contract Dodge City to Colorado State line, 125 miles, projected, State line to Trinidad, Colo., 150 miles, President, C. D. Perry, Dodge City, Kan.

1. ***Atchison, Topeka & Santa Fé.***—Track laid—Great Bend Extension, Alexandria to Crosby, 91.7 miles.—Augusta Extension, Augusta to Mulvane, 20.8 miles—Leavenworth, Northern & Southern Ry., Hawthorne to Wilder, 46.2 miles—Mulvane Extension, Cartyne to Englewood, 86.6 miles—Girard Extension, 2.2 miles—Frontenac Extension, 5.2 miles—Ellinor to Gladstone, 2.6 miles, Gladstone to Bazar, 7.2 miles—Burlington branch, Burlington to Gridley, 11.1 miles—Little River Extension, 0.1 miles—Neosho Falls to Yates Center, 14.1 miles—Benedict Extension, Coyville to Madison, 28 3 miles—Strong City Extension, Strong City to Concordia, 123.75 miles, Manchester to Barnard, 43.2 miles, Abilene to Salina, 22, 25, making a total on Strong City Extension of 189.2 miles—Larned Extension Brown's Grove to Jetmore, 23 miles—Southern Kansas & Panhandle Ry., Medicine Lodge to Lake City, 22.9 miles; under construction, Bazar to Eldorado, 50 miles; under contract, Chicago, Kansas & Western, Chanute to Fort Scott, 45 miles; surveyed, end of Great Bend Extension to Colorado Springs, Colo., 175 miles.

20. ***Chicago, Burlington & Quincy.***—Track laid, Nebraska State line to Blakeman, 35 miles; under construction, Blakeman to Wano, 35 miles.

21. ***Chicago, Rock Island & Pacific.***—Chicago, Kansas & Nebraska system.—Track laid, Holton to Kingsdown, 294 miles—Fairbury, Neb., to Norton, Kan., 174 miles, Herington to Caldwell, 124 miles, Herington to Salina, 60 miles, McFarland to Belleville, 104 miles; under construction Kingsdown, southwest to State line, 80 miles; under survey, Norton to Colorado Springs, Colo., 300 miles.

22. ***Garden City Nickel Plate.***—Surveyed, Garden City to Hays City, 100 miles. Address, Jno. A. Stevens, Garden City, Kan.

22.½ ***Kansas City & Pacific.***—Track laid, Parsons to Selma, East line Linn Co., 61 miles; projected, end of track, north, 32 miles. President, C. H. Kimball, Parsons, Kan. Chief Engineer, D. W. C. Perry, Parsons, Kan.

23. ***Kansas City, Wyandotte & Northwestern.***—Track laid, end of track, 11.2 miles from Kansas City to Seneca, Kan., 117 miles.

10. ***Missouri Pacific.***—Track laid,—St. Louis, Ft. Scott & Western Ry., Corwin to Kiowa, 8 miles—St. Louis, Newton & Denver Ry., Leroy to Madison, 26 miles—Denver, Memphis & Atlantic, Turon to Larned and Cedarvale to Belle Plaine, 124 miles, Olcott to Iuka 20 miles—Pueblo & State Line Ry., Pueblo, Colo. to Kansas State line, 153 miles—Monon to Great Bend, 10 miles, Gypsum City to Marquette, 27 miles, Dexter to Arkansas City, 25 miles, Geneseo to Kanapolis, 14 miles, between Geneseo and Hutchison, 27 miles, east line of Ness Co. to Colorado State line, 138 miles; under survey—Denver, Memphis & Atlantic Ry., Chetopa to Joplin, Mo., 30 miles; also projected, Winfield to Caldwell, 40 miles, and Iuka to Dodge City, 75 miles.

11. ***St. Louis & San Francisco.***—Track laid, Kansas Midland Ry—Wichita to Ellsworth, 104.15 miles, Pittsburg to Weir City, 8.8 miles.

24. ***Union Pacific.***—Track laid, Oakley to Colby, 25 miles—Salina, Lincoln & Western Ry., Lincoln Center to Waldo, 25.3 miles. Projected, Lincoln, Colorado & Western R. R., Waldo west to Colorado State line, 175 miles.

New Projects and Surveys.

25. ***Chicago, Kansas & Arkansas.***—Located, St. Joseph, Mo., to Lawrence, 70 miles; projected to Arkansas City, Kan., Springfield, Mo., and Galveston, Tex. (See ENGINEERING NEWS of Dec. 31, 1887). Chief Engineer, Joseph Broaddus St. Joseph, Mo. Secretary, W. G. Seaver, St. Joseph, Mo.

26. ***Chicago, Kansas & Southwestern.***—Surveyed, Hiawatha to Arkansas City, 200 miles. Two companies have been formed to build the line. Joseph Jackson, Marysville, Mo., is President of the Missouri company, and A. J. Schilling, Hiawatha, Kan., of the Kansas company.

27. ***Inter-State & Denver.***—Projected, Madison, west to a connection with the Missouri Pacific Ry., in Salina Co., 100 miles. (Missouri Pacific interest.) President, A. E. Godeffroy, 146 Broadway, New York. Secretary, Alex. E. Case, Marion, Kan.

28. ***Kansas City, Lawrence & Nebraska.***—Surveyed, North Lawrence to Grand Island, Neb., 279 miles, and from near Randolph to Brantford, 33 miles. President, Howard M. Holden, Kansas City. Chief Engineers, Breithaupt & Allen, Kansas City, Mo.

29. ***Lawrence, Atchison & Southern.***—Surveyed, Atchison to Lawrence, 55 miles; projected, Lawrence to Quenomo, 45 miles. President, J. B. Bowersock, Lawrence, Kan. Vice-President, W. D. Morton, Winchester, Kan.

30. ***New Orleans, Natchez & Ft. Scott.***—Projected, New Orleans, La., to Ft. Scott., 640 miles. President, Jno. H. Rice, Ft. Scott, Kan.

31. ***Wichita, Cedarvale & Southern.***—Projected, Wichita to Denver, Memphis & Atlantic R. R., 65 miles. President, H. J. Neiderlander, Wichita, Kan. Chief Engineer, Edward Barrington, Superior, Neb.

Total.—Track laid, 1,889 miles; In process of construction, 335 miles. Surveys, 830 miles. Projects, 557 miles.

INDIAN TERRITORY.

Existing Roads.

1. ***Atchison, Topeka & Santa Fé.***—Track laid—Kiowa extension, Alva to Indian Territory and Texas line, 102.9 miles—Arkansas City extension, Mendota to Purcell, 98.3 miles—Gulf, Colorado & Sante Fé, R. R., Red River to Purcell, 107 miles.

21. ***Chicago, Rock Island & Pacific.***—Surveyed—Kansas, Colorda & Texas R. R., Caldwell, Kan., to Wichita Falls, Tex., 250 miles.

10. ***Missouri Pacific.***—Under construction—Kansas and Arkansas Valley Ry., Van Buren to Waggoner, 83 miles; projected, Waggoner to Arkansas City, Kan., 130 miles.

11. ***St. Louis & San Francisco.***—Track laid, between Ft. Smith, Ark., and Paris, Tex., 113.32 miles; surveyed, Sapulpa to Texas Panhandle, 334 miles; projected to Albuquerque, N. M., 300 miles.

Total.—Track laid, 408.2 miles. In process of construction, 83 miles. Surveys, 569 miles. Projects, 466 miles.

ARKANSAS.

Existing Roads.

32. ***Eureka Springs.***—Surveyed, Eureka Springs to Harrison, 49 miles.

33. ***Kansas City, Texarkana & Gulf.***—Under survey, Texarkana to Ft. Smith, 150 miles. President, C. C. Donian, Texarkana, Ark.

10. ***Missouri Pacific.***—Track laid—Bald Knob branch, between Bald Knob and West Memphis, 64 miles, under survey, Ft. Smith to Gurdon, 150 miles; projected, Little Rock, Mississippi River & Texas R.R., Warrenton to Camden, 40 miles.

34. ***Pine Bluff, Monroe & New Orleans.***—Surveyed Pine Bluff to Monroe, La., 125 miles; projected, Rob Roy to Little Rock, Ark., 45 miles. President, C. M. Neel, Pine Bluff, Ark. Chief Engineer, J. J. Martin, Pine Bluff, Ark.

12. ***St. Louis, Arkansas & Texas.***—Track laid—Arkansas & Southwestern line, Lewisville to Canfield, 13 miles—Little Rock & Eastern R.R., Altheimer to Quapano Lake, 9 miles; under construction—Arkansas & Southwestern line, Canfield to Shreveport, La., 47 miles—Little Rock & Eastern R. R., Quapano Lake to Little Rock, 41 miles; under survey, Magnolia to Homer, La., 37 miles.

11. ***St. Louis & San Francisco.***—Track laid, Jensen to Mansfield, 18.34 miles; Fayetteville to St. Paul, 33.29 miles; surveyed, Mansfield to Little Rock, 120 miles.

New Projects and Surveys.

35. ***Arkansas & Grand Prairie.***—Projected, Beebe to Pine Bluffs, 75 miles. President, G. M. Barbour Chicago, Ill. Secretary, J. D. Foster, Beebe, Ark.

36. ***Camden & Northwestern.***—Projected, Camden, northwest to St. Louis, Iron Mountain & Southern R. R., 40 miles. Secretary, Richmond Hibbard, Camden, Ark.

37. ***Houston, Central Arkansas & Northern.***—Surveyed, Pine Bluff to Alexandria, La., 235 miles; under survey, Alexandria, La., toward Houston, Tex., 110 miles. President, W. A. Bright, Little Rock, Ark. Chief Engineer, Jas. Converse, San Antonio, Tex.

38. ***Kansas City, Arkansas & New Orleans.***—Under survey, Beebe to Monroe, La., 200 miles. President, Geo. M. Barbour, Beebe, Ark. Chief Engineer, W. R. Bergholz, 15 Cortlandt St., New York.

39. ***Little Rock & Alexandria.***—Projected, Little Rock, Ark., to Alexandria, La., 250 miles. President, B. A. Johnson, Camden, Ark.

40. ***Little Rock & Hot Springs.***—Surveyed, Little Rock to Hot Springs, 56 miles. President, R. A. Edgerton, Little Rock, Ark. Chief Engineer, G. M. French, Little Rock, Ark.

41. ***Memphis, Arkansas & Texas.***—Under survey, Memphis, Tenn., to Clarendon, Ark., 70 miles. President, Geo. Arnold, Memphis, Tenn. Chief Engineer, Thos. G. Dabney, Memphis, Tenn.

42. ***Mississippi Valley.***—Surveyed, Arkansas City to West Baton Rouge, La., 260 miles. President, Hiram R. Steele, Natchez, Miss.

43. ***Newport, Jonesboro & St. Louis.***—Projected, Newport to Jonesboro, 40 miles. Chief Engineer, Felix Simmonds, Newport, Ark.

44. ***Paragould & Buffalo Island.***—Surveyed, Paragould to Cotton Plant, Mo., 23 miles. Jno. B. Boykin, Chief Engineer, Paragould, Ark. A. Bertig, Treasurer Paragould, Ark.

Total.—Track laid, 137 miles. In process of construction, 48 miles. Surveys, 1,172 miles. Projects, 730 miles.

LOUISIANA.

Existing Roads.

45. ***Arkansas & Louisiana.***—Surveyed, Hope, Ark., to Alexandria, La., 200 miles. Receiver, W. P. Hart, Washington, Ark.

East Louisiana.—Track laid, between New Orleans and Abita Springs, 16 miles. Address Poitevent & Favre, St. Charles St., New Orleans, La.

Jeanerette, Abbeville & Western.—Located and partly graded, Jeanerette to Abbeville, 30 miles. President, F. M. Welch, Jeanerette, La. Chief Engineer, A. Faselieur, Jeanerette, La.

46. ***Natchitoches.***—Track laid, Prudhomme to Natchitoches, 11.1 miles; under survey, Natchitoches to Red River, 15 miles, projected, Red River to Gibsland, 55 miles, and to Shreveport, 60 miles. Superintendent, W. W. Logan, Natchitoches, La.

New Orleans & Gulf—formerly Shell Beach Ry. Track laid, Poydras to Bohemia, 35 miles.

New Projects and Surveys.

47. ***Alexandria & Arcadia.***—Projected, Alexandria to Arcadia, 140 miles. President, A. L. Atkins, Arcadia, La. Chief Engineer, Leon N. Polk, Arcadia, La.

48. ***Kansas City, Watkins & Gulf.***—Under survey, Lake Charles to Shreveport, 150 miles. Address, Jabez B. Watkins, Lawrence, Kan.

49. ***Louisiana, Arkansas & Missouri.***—Projected, Brinkley, Ark., to Alexandria, La., 260 miles. President, Arthur W. Soper, New York City.

50. ***St. Paul, Alexandria, Lake Arthur & Gulf.***—Projected, Alexandria to Jennings and Lake Arthur, 110 miles. President, E. R. Shankland, Jennings, La. Chief Engineer, Kasson Freeman, Jennings, La.

Total.—Track laid, 62 miles. In process of construction, 70 miles. Surveys, 867 miles. Projects, 815 miles.

TEXAS.

Existing Roads.

1. ***Atchison, Topeka & Santa Fé.***—Track laid.—Southern Kansas of Texas, Indian Territory line to Panhandle City, 95.8 miles; projected, Panhandle City to El Paso *via* New Mexico, 400 miles.

51. ***Austin & Northwestern.***—Under construction, Burnet to Lampasas, 20 miles.

21. ***Chicago, Rock Island & Pacific.***—Projected, Kansas, Colorado & Texas R. R., Wichita Falls to San Antonio.

52. ***Denison, Bonham & New Orleans.***—Under construction, Denison to Bonham, 45 miles; projected, Bonham to Mount Pleasant, 75 miles; President, S. B. Allen, Bonham, Tex.; Chief Engineer, Fred. P. James, Denison, Tex.

53. ***Denison & Washita Valley.***—Track laid, Denison to Red River, 6 miles; located, Red River to coal fields near Lehigh, Ind. Ter., 60 miles; projected, near Lehigh, Ind. Ter., to Ft. Smith, Ark., 160 miles. Secretary, Edward Perry, Denison, Tex.

54. ***Fort Worth & Denver City.***—Track laid, Quanah to State line, 262 miles; under construction (to be completed in March) Washburn to Panhandle City, 16 miles.

55. ***Fort Worth & Rio Grande.***—Track laid, Ft. Worth to Granbury, 40.2 miles; projected, Granbury to Brownwood, 108 miles. General Superintendent, C. B. Colton, Ft. Worth, Tex.

1. ***Gulf, Colorado & Santa Fé.***—Track laid, Ladonia to Paris, 31 miles, Cleburne to Weatherford, 40 miles; projected, Ballinger to San Angelo, 40 miles, Dallas to Gainesville, 40 miles.

56. ***Marshall, Paris & Northwestern.***—Surveyed, 18 miles northwest of Marshall to Paris, 100 miles; projected, Paris northwest, 56 miles.

10. ***Missouri Pacific.***—Track laid, Gainesville Henrietta & Western R. R., Gainesville to Henrietta, 69.9 miles—Taylor, Bastrop & Houston Ry., Bastrop to Fayetteville, 46 miles; under construction, between San Marcos and Sealey, 40 miles—Dallas & Hillsboro Ry., Dallas to Hillsboro, 65 miles; projected, Henderson to Centre, 50 miles.

11. ***St. Louis & San Francisco.***—Surveyed, Paris to Roberts, 67 miles.

12. ***St. Louis, Arkansas & Texas.***—Track laid, Commerce to Remer, 57 miles, Corsicana to Hillsboro, 40 miles, from 5 miles west of Mount Pleasant to Sherman 110 miles; under construction, including 20 miles track laid since Jan. 1, end of track to Ft. Worth, 41 miles.

57. ***San Antonio & Aransas Pass.***—Track laid, San Antonio to Kerrville, 72 miles, Cuero to Wallis, 91 miles, Yoakum to Flatonia, 30 miles; under construction, near Skidmore to Collins, 45 miles; located, Flatonia to Waco, 140 miles, Wallis to Houston, 45 miles; projected, Kerrville, north, 100 miles, Houston to Alexandria, La., and Natchez, Miss., 275 miles.

Southern Pacific.—Projected, Victoria to Beeville, 60 miles.

58. ***Texas, Sabine Valley & Northwestern.***—Track laid, Tatum to Beckville, 6.45 miles; under construction Beckville to Carthage, 10 miles, (track is now laid,); projected, Carthage to Sabine Pass, 200 miles. From Carthage to Houston, East & West Ry. Jc., 17 miles, and from Longview to Marshall, Paris & Northwestern Ry., 12 miles, will be built this year. Chief Engineer, R. J. Evans, Longview, Tex.

New Projects and Surveys.

59. ***Austin & McGregor,***—Under survey, Austin to McGregor, 84 miles. President, Jos. Nalle, Austin, Tex. Secretary, A. P. Woolridge, Austin, Tex.

60. ***Dallas & New Orleans.***—Projected, Ft. Worth southeast to Louisiana State line in Newton Co., 275 miles. President, Morgan Jones, Ft. Worth, Tex.

61 ***Denison & Sherman.***—Under survey, Denison to Sherman, 10 miles. President, W. B. Munson. Address in care of Edw. Perry, Secretary Denison and Washita Valley R. R. Co., Denison, Tex.

62. ***Fort Worth Western.***—Under survey, Ft. Worth to Belknap, 100 miles. President, W. H. H. Lawrence, Ft. Worth, Tex. Chief Engineer, M. O. Hall, Ft. Worth, Tex.

63. ***Gainesville & Southwestern.***—Projected, Gainesville to Decatur, 50 miles. Headquarters of Company at Gainesville, Tex.

64. ***Galveston Air Line.***—Projected, Houston to Paris, 275 miles. President, W. L. Moody, Galveston, Tex.

65. ***New Orleans, Mexia, Cleburne & Northwestern.***—Projected, Mexia to Cleburne, 75 miles. Headquarters of Company at Mexia, Tex.

66 ***Sabine River.***—Surveyed, Logansport, La., to Center, Tex., 17 miles. Address, A. Wilson Oliver, Center, Tex.

67. ***Waco & Brazos.***—Under survey, Waco to Cameron, 65 miles. President, William Cameron, Waco, Tex.

Total.—Track laid, 1,005 miles. In process of construction, 282 miles. Surveys, 703 miles, Projects, 2,023 miles.

ILLINOIS.

Existing Roads.

68. ***Centralia & St. Genevieve.***—Under construction, Centralia to a point opposite St. Genevieve, 70 miles. President, Thos. B. Needles, Nashville, Ill. Chief Engineer, H. W. Schmidt, Red Bud, Ill.

69. ***Jacksonville Southeastern.***—Track laid, Centralia to Driver's Station, 17.9 miles; projected, Driver's Station to Benton, 23 miles.

70. ***Kaskaskia, St. Elmo & Southern.***—Projected, Altamont to Paducah, Ky., 160 miles. President, B. F. Johnson, St. Elmo, Ill.

71. ***St. Louis, Alton & Springfield.***—Surveyed, Alton to Elsah, 12 miles, also—Calhoun & Northwestern R. R., Grafton, north, 50 miles. General Manager, H. A. Fisher, St. Louis, Mo.

72. ***St. Louis, Alton & Terre Haute.***—Track laid—Chicago, St. Louis & Paducah Ry., Marion to Baker City, 15 miles; under contract, Baker City to Paducah, Ky., 40 miles.

72. ***St. Louis & Chicago.***—Track laid, Litchfield to Mt. Olive, 10 miles; under survey, Mt. Olive to East St. Louis, 42 miles.

12. ***St. Louis, Arkansas & Texas.***—Surveyed, Grand Tower to St. Louis, 100 miles.

New Projects and Surveys.

74. ***Cairo & Northwestern.***—Projected, Cairo to East Cape Girardeau, 45 miles. Secretary, H. Wells, Cairo, Ill.

75. ***Chicago, Paducah & New Orleans.***—Projected, Effingham, south, to a connection with Paducah & Mt. Vernon Ry., 75 miles. Address, A. G. Murray, Springfield, Ill.

76. ***Paducah & Mt. Vernon.***—Under contract, Cypress Jc. to Paducah, Ky., 66 miles; projected, Cypress Jc. to Mt. Vernon, Ind., 44 miles. Address, Amasa Mason, 120 Broadway, New York City.

77. ***Springfield & Southern.***—Located, Springfield to Pinckneyville, 125 miles. President, Rufus M. Ramsey, Carlyle, Ill. Chief Engineer, Geo. W. Davis, 219 So. 23d St., St. Louis, Mo.

KENTUCKY.

Existing Roads.

78. ***Cairo & Tennessee River.***—Under construction, Cairo to Mayfield, Ky., 40 miles; under survey, Mayfield to Paris, Tenn., 50 miles; projected, Paris, Tenn., to Florence, Ala., 85 miles. President, B. A. Neal, Mayfield, Ky.

79. ***Louisville & Nashville.***—Track laid—Indiana, Alabama & Texas Ry., Clarksville to Cerulean Springs, 43 miles; under survey, Gracey to Cadiz, 10 miles.

80. ***Louisville, St. Louis & Texas.***—Under construction, Louisville to Henderson, 135 miles. President, J. C. Fawcett, Louisville, Ky.

81. ***Ohio Valley.***—Track laid, Morganfield to Uniontown, 6.5 miles, Dekoven to Ohio River, 2 miles, Sturgis to Princeton, 44.7 miles; surveyed, Princeton to Cadiz, 40 miles.

New Projects and Surveys.

82. ***Marion, Princeton & Ohio River.***—Under survey, Marion to a point opposite Elizabethtown, Ill., 16 miles. Secretary, Jno. W. Blue, Marion, Ky.

TENNESSEE.

Existing Roads.

83. ***Illinois Central.***—Surveyed, Cairo to Memphis 200 miles.

84. ***Tennessee Midland.***—Track laid, Jackson, west, 5 miles; under construction, end of track to Memphis, 80 miles. President, A. S. Buford, Memphis, Tenn.

84½. ***Troy & Tiptonville.***—Under survey, Troy to Tiptonville, 30 miles; projected, Tiptonville to Hoxie, Ark., 75 miles. President, Geo. B. Wilson, Troy, Tenn. Chief Engineer, Jno. B. Inman, Troy, Tenn.

New Projects and Surveys.

85. ***Humboldt & Dyersburgh.***—Projected, Humboldt to Dyersburgh, 35 miles. Address, Jno. B. Inman, Troy, Tenn.

MISSISSIPPI.

Existing Roads.

86. ***Corinth & Tennessee River.***—Under contract, Corinth to Pittsburg, Tenn., 20 miles. President, C. B. Howery, Oxford, Miss. Chief Engineer, Jno. B. Inman, Troy, Tenn.

87. ***Georgia Pacific.***—Located, Columbus to Johnson, 134 miles.

88. ***Gulf & Ship Island.***—Track laid, Cotton Plant to Pontotoc, 25 miles, Gulfport to Biloxi River, 11 miles; Under construction, Biloxi River to Hattiesburg, 64 miles; surveyed, Hattiesburg to Carthage, 100 miles; projected, Carthage to Pontotoc, 115 miles.

Louisville, New Orleans & Texas.—Surveyed, Centreville to Woodville, 15 miles; projected, Glen Ellen to Rolling Fork, 20 miles.

90. ***Natchez, Jackson & Columbus.***—Projected, Jackson to Columbus, 120 miles.

91. ***Warrior Coal Fields.***—Under construction, Meridian to Gainesville, Ala., 55 miles; Chief Engineer, J. W. Gallup, Meridian, Miss.

New Projects and Surveys.

92. ***Artesia, Starkville & Grenada.***—Surveyed, Starkville to Grenada, 69 miles. President, L. D. McDowell, Starkville, Miss. Chief Engineer, R. H. Elliott, Memphis, Tenn.

93. ***Memphis, Oxford & Columbus.***—Projected, Memphis, Tenn., to Columbus, 150 miles. President, F. M. Abbott, Abbott, Miss. W. H. Crampton, 136 S. Clark St., Chicago, Ill.. President of Construction Company.

94. ***Mobile, Hattiesburg & Jackson.***—Projected, Mobile, Ala., to Jackson, Miss., 175 miles. President, Jno. Kemper, Enterprise, Miss. Chief Engineer, S. D Brown, Mobile, Ala.

95. ***Tombigbee.***—Surveyed, Columbus to Decatur, Ala., 131 miles; projected, Columbus to Jackson, 140 miles. President, B. A. Vaughn, Columbus, Miss.

COLORADO.

Existing Roads.

Atchison, Topeka & Santa Fé.—Track laid—Denver & Santa Fé.—Pueblo to Denver, 116.8 miles. Pueblo & Arkansas Valley.—Cleiland to Canon City, 6.8 miles; Brookside to Mine No. 7, 1.3 miles; Canon City to Mine No. 5, 1.7 miles.

Chicago, Burlington & Quincy.—Surveyed, Kansas State line to Pueblo, 170 miles.

Chicago, Rock Island & Pacific.—Projected, from main line to Denver and Trinidad and south to a connection with New Mexico line, 250 miles.

Denver, Texas & Gulf.—Track laid, Trinidad southwest, 50 miles. Just approaching completion to a junction with Fort Worth & Denver City Railroad.

Proposals Open.

Reservoir.—Cost not to exceed $50,000. THE WATER-WORKS COMMITTEE, Wheeling, W. Va.

Iron Bridge.—Across the Colorado river. THE COUNTY COMMISSIONERS, Ballinger, Runnels Co., Tex.

Railroad.—From Tar river to Durham county line. JOHN C. WINDER, President, Durham & Northern R. R. Co., Raleigh, N. C. March 5.

Broken Stone and Gravel.—Broken trap rock 7,800 cu. yds.; 4,200 cu. yds. trap rock screenings 1,000 cu. yds. Roa Hook screened gravel. THE PARK COMMISSIONERS, 49-51 Chambers, St., New York City. March 7.

Sewers.—At Greenbush, N. Y. LANDRETH, FITZGERALD & PRESCOTT, Engineers, Schenectady, N. Y. Bids opened at Greenbush, March 8.

Wooden Pier.—At foot of Rivington St., East river. THE DOCK COMMISSIONERS, Pier A, North river, New York City. March 9.

Lock Tender's House.—At Tuskaloosa, Ala. Major A. N. DAMRELL, U. S. Engineer Office, Mobile, Ala. March 10.

Excavation and Filling.—About 40,000 cu. yds., of street grading, etc., at Woodhaven, N. Y. JAMES F. DEEHAN, Surveyor, Woodhaven. Bids to be sent to W. H. PITKIN, Albany, N. Y. March 10.

Street Work.—Pine wood blocks, treated with chloride of zinc; asphalt paving, granite block paving. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. March 12.

Building.—Farmers' exchange. ALBERT ULRICH, architect. J. B. REILLY, Secretary, Farmers' Alliance Exchange, Dallas, Tex. March 12.

Wrought Iron Tank.—For Breed's Id. H. T. ROCKWELL, Chairman, Water Board, Boston, Mass. March 12.

Granite Stones.—For bulkhead or river wall; 391 headers and 465 stretchers, about 18,300 cu. ft. The DOCK COMMISSIONERS, Pier A, North river, New York City. March 13.

Pipe, Castings, Etc.—About 670 tons of 36-in. cast-iron coated water pipe, 35 tons of 36-in. special castings, one 36 in. valve. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. March 13.

Water-Works.—Engine, pumping machinery and pipe. Plans and specifications on file. JOHN CLAXTON, Chairman, Water-Works Committee, Paisley, Ont., Canada. March 14.

Water-Works Debentures.—For $8,000, 5%. T. D. GALLOWAY, Town Clerk, Wiarton, Ont., Canada. March 15.

Hotel.—International hotel. CHARLES RIPLEY & Co., Sault Ste. Marie, Mich. March 15.

Slip.—Pile and timber slip for fire boat, on Cuyahoga river. A. J. SPENCER, Secretary, Board of Fire Commissioners, Cleveland, O. March 15.

Dredging.—Cheboygan harbor. Lt. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich. March 19.

Reservoirs and Pipe Line.—Reservoirs at Tivoli lake, Patroon's creek and Sand creek, with connecting pipe lines. A. VANDER VEER, President, Special Water Commission, Albany, N. Y. March 19.

Lighthouses.—At Deer Island, Boston, Mass., and Lubec Narrows, Me. Major W. S. STANTON, U. S. Lighthouse Engineer, Boston, Mass. March 20.

County Court House.—At Mayfield, McDONALD Bros., architects, Louisville, Ky. J. E. ROBBINS, County Judge, Mayfield, Graves county, Ky. March 20.

Masonry Foundations.—For town hall and public library at Wolfborough, N. H. J. T. KELLEY, 75 Pinckney St., Boston, Mass., architect. THE TRUSTEES OF BREWSTER ESTATE, 35 Congress St., Boston, Mass. March 23.

Water-Works Tunnel.—Under Lake Erie, from the Division St. pumping station to the inlet protection crib, 9,200 ft. There will be 5 shafts, 8-ft. diameter; 1 inlet shaft at crib, 1 working crib near shore, 3 shafts at pumping station: land shafts lined with cast-iron cylinders 1¼ in. thick for depth of 36 ft., inlet shaft cylinders 2-in. thick for 81 ft. JOHN WHITELAW, Superintendent and Engineer of Water-Works, Cleveland, O. March 24.

Drilling and Blasting.—At St. Mary's Falls canal. Lt. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich. March 26.

Water-Works.—Complete system of works, to be built during the present year. Bids to be based on system, plans and specifications proposed by bidder, without expense to the city. N. H. HAGEBUSCH, Clerk, Water-Works Committee, Washington, Mo. April 2.

Contracting.

The Bower-Barff Rustless Iron Co., 35 Broadway, New York, have issued another pamphlet descriptive of the well known Bower-Barff process. There are tables of tests of strength of iron treated by this process, and a number of testimonials on the value of "rustless" iron for architectural work, water pipe, etc. Also views of the furnace used for treating the iron.

Water-Works for Salisbury, Md.—Water-works are projected and proposals are invited from contractors. It is intended to begin work by March 15 and complete it by May 5. The works will be put in by the Salisbury Water Co.: President, S. P. DENNIS; Secretary and Treasurer, L. S. BELL; capital stock, $50,000. The works were designed by L. S. BELL. The supply will be drawn from wells and pumped to stand-pipe 12 ft. diameter and 100 ft. high; direct pumping is also provided for. Duplex compound pumps, with a daily capacity of 500,000 galls., and return tubular boiler will be used. There will be 3 miles of cast-iron mains, 2 meters and 25 hydrants. The service pipe will be galvanized iron and lead. Ordinary pressure, 51 lbs; fire pressure, 125 lbs. Some pipe has been bought, but no contracts have been let; the company proposes to put up the buildings and do the trenching and pipe laying by day work. Population, 3,500. Address Dr. L. S. BELL.

Hauling.—The following proposals for hauling dirt and macadam have been received by Capt. J. W. JACOBS, Asst. Quartermaster, U. S. A., Atlanta, Ga.: E. M. & J. W. Clayton, $3 per team per day, $2 per cart per day; J. R. Davis, $5, $3; J. W. McGinty, $4.67½, $3; Wm. McConnell, $3.97, $3.25; W. T. Culom, $4.25, $2.60.

Wire Fencing.—The Washburn & Moen Mfg. Co., 16 Cliff St., New York, has the contract for furnishing the material and building 20 miles of wire fence on the Lehigh Valley R. R. in New Jersey: also for fencing the Rochester, Hornellsville & Lackawanna R. R. in New York.

Bridge Contracts.—*Boston, Mass.*—The following proposals for an iron bridge, 35 ft. long and 60 ft. wide, over the Boston, Revere Beach & Lynn R. R., at Wood Island Park, East Boston, were received by the Park Commissioner, Feb. 24; Berlin Iron Bridge Co., East Berlin, Conn., $2,022; Cofrode & Saylor, Philadelphia, $2,075; Boston Bridge Co., $2,636; R. F. Hawkins, Springfield, Mass., $2,710; King Iron Bridge & Mfg. Co., Cleveland, O., $2,980; Atlantic Works, Boston, $2,991.

Brattleboro, Mass.—The contract for an iron bridge over Whetstone brook at Elm St., has been awarded to the Vermont Construction Co., St. Albans, Vt.

Washington, La.—The contract for building the iron drawbridge over Bayou Courtableau at Main St., has been awarded to the King Iron Bridge & Mfg. Co., of Cleveland, O., the only bidder, at $5,600. The bridge is to be completed by Aug. 1.

Murfreesboro, Tenn.—The contract for an iron bridge across Lytle creek, on West Main street, has been awarded to the Pittsburg Bridge Co.

Raleigh, N. C.—The contract for 2 iron bridges has been awarded by the County Commissioners to the King Iron Bridge & Manufacturing Co., Cleveland, O., for $8,500.

Green Bay, Wis.—The following proposals for an iron drawbridge at Walnut St., over Fox river, have been received: Superstructure; Wisconsin Bridge Co., Milwaukee, Wis., $9,475; Lane Bridge & Iron Works, Chicago, $9,490, $10,950; Milwaukee Bridge & Iron Works, Milwaukee, Wis., $9,500, $9,975; King Iron Bridge & Manufacturing Co., Cleveland, O., $9,610; Wrought Iron Bridge Co., Canton, O., $9,645; Minneapolis Bridge Co., Minneapolis, Minn., $9,700; Massillon Bridge Co., Massillon, O., $9,800; Smith Bridge Co., Toledo, O., $9,890; Mount Vernon Bridge Co., Mount Vernon, O., $10,200; A. Y. Bayne & Co., Minneapolis, Minn., $10,500; Kansas City Bridge & Iron Co., Kansas City, Mo., $10,500. The contract was awarded to the Lane Bridge & Iron Works at $9,490.—Substructure: Lane Bridge & Iron Works, $3,979; C. Berner, Green Bay, Wis., $4,761. The contract was awarded to the Lane Bridge & Iron Works. O. J. B. BRICE is City Clerk.

Water Works.—*Findlay, O.* The following proposals were received Feb. 15 by the Water-Works Trustees, JOHN W. HILL, of Cincinnati, O., Consulting Engineer: *Pipe and Specials*; 26, 276 net tons of cast-iron pipe, and 114,000 lbs. of specials: Addyston Pipe & Steel Co., $70,074.40; Huston & Freeman, $70,074.40; Lake Shore Foundry, $72,089.63; Ohio Pipe Co., $75,253.97; W. H. Campfield, $75,253.97; National Pipe & Foundry Co., $78,-710.33; R. D. Wood & Co., $79,075.24; Dennis Long & Co., $83,301.77; Mellert Iron & Foundry Co., $86,170; Builders' Iron & Foundry Co., specials, $2,600.—*Pipe laying and concrete*; 5,016 ft. of 4-in. pipe, 38,136 ft. of 6-in., 16,636 ft. of 8-in., 10,913 ft. of 10-in., 4,310 ft. of 12-in., 1,450 ft. of 14-in., 7,770 ft. of 16-in., 5,370 ft. of 20-in.: 55.63 cu. yds. of concrete: Jas. J. Rumsey, $23,820.71; W. H. Campfield, $25,537.69; P. Sullivan, $26,355.33; A. G. Pugh, $27,785.61; Snyder & Williams, $28,316.20; Huston & Freeman, $33,-920; P. E. Sullivan, $37,168.65; Vanston & McCarthy, $38,-398.48.

Stop Valves; 8 4-in., 56 6-in., 21 8-in., 12 10-in., 3 12-in., 1 14-in., 4 16-in., 2 20-in.: Jas. Flower & Bros., $2,086; Galvin Iron & Brass Works, $2,130.50; Bourbon Copper & Brass Works, $2,222; Ludlow Valve Co., $2,224.80; Eddy Valve Co., $2,253.50; Chapman Valve Co., $2,338.47; Huston & Freeman, $2,357; Holly Mfg. Co., $2,566.50; Mellert Foundry Co., $2,409.—*Stop boxes*, 107; Galvin Iron & Brass Works, $267.50; Bingham & Taylor, $346.10; Eddy Valve Co., $347.75; A. W. Morgan, $337.05, $353.10, $371.29; Huston & Freeman, $481.50, Mellert Foundry Co., $1,605; Builders' Iron Foundry, $321.—*Hydrants*; 6 4-in., 133 6-in.; without frost case; Ludlow Valve Co., $3,716.94; $3,949.69, $4,255.64, $5,213.19; Chapman Valve Co., $4,102.42, $5,113.22; with frost case, Galvin Iron & Brass Works, $4,140; $4,557; Ludlow Valve Co., $4,231.24, $4,523.84, $4,898,-90, $5,974.87; Bourbon Copper & Brass Works, $4,400 $4,548, $4,823, $4,932, $5,479; Chapman Valve Co., $4,633.05, $5,754, $5,787.49; Mellert Foundry Co., $4,835; R. D. Wood & Co., $4,925.75; Huston & Freeman, $4,953; Holly Mfg. Co., $5,161.50; Jas. Flower & Bros., $5,281.90; Holyoke Hydrant Works, $5,465.89; Eddy Valve Co., $6,020.

Pumping Machinery—2 compound, duplex, non-condensing engines, of 2,500,000 galls. capacity each, and 3 boilers, 66 ins. by 16 ft.; Gordon & Maxwell, $15,600, $14,700; Holly Mfg. Co., $21,760, (rotative) $24,700; Deane Steam Pump Co., $27,700; Cooper Mfg. Co., $18,300.—*Works*, including pipe, specials, hydrants, valves, boxes, pipe laying and concrete, complete; Snyder & Williams, $108,674.42; Huston & Freeman, $112,085.59.

Bridge Abutmen's.—The International Tramway & Bridge Co., Laredo, Tex., has awarded the contract for the stone abutments of the bridge across the Rio Grande, to J. Estetter. There are now two bridges under construction across the Rio Grande at Laredo.

Bridge Works.—Lane Bros., bridge builders, Newark, O., are erecting works at that city and expect to occupy them by June 1.

Piles.—The following proposals for 550 white or yellow pine, spruce or cypress piles have been received by the Dock Commissioners, New York City: A. J. Murray, 450 piles 65 to 70 ft. long, $11 each; 100 piles 70 to 75 ft. long, $14 each; Beard & Kempland, $11.25, $14.25; Charles B. Carman, $11.40, $14.70. The contract was awarded to A. J. Murray.

Pumping Engine and Boilers.—The only bids received February 23, by the Board of Public Affairs, Cincinnati, O., for a high service pumping engine of 10,000,000 galls. daily capacity, to pump water from the Eden reservoir to the Mt. Auburn service, were from Henry R. Worthington, New York, $37,325 and $42,100. —The following were the proposals for boilers: Heine Safety Boiler Co., St. Louis, Mo., $17,115; Charles Ward, Charleston, W. Va., $20,000; Laidlaw & Dunn, $20,795; Abendroth & Root Mfg. Co., $21,603.40.

Cleaning Streets and Sewers.—The following were the proposals received February 20 by the Board of Public Works, Jersey City, N. J. Street cleaning; Bernard Shandley, $10 per mile for 550 miles of streets, $6,000 for removing ashes, $2,500 for removing garbage, $14,000 total; Henry Byrnes, $11, $11,800, $2,000, $19,850; Jos. H. Maillie, $17, $9,000, $2,000, $20,350; W. R. Cook, $19, $11,000, $1,500, $22,950; Laurence Carey, $19, $9,500, $3,500, $23,450; Wm. McCarthy & H. Kenney, $15, $13,800, $2,500, $24,550; Dennis Byrnes, $10, $16,000, $3,125, $24,625.—Cleaning, 47,250 ft. of main sewers, 95,000 ft. of lateral sewers and 900 receiving basins: Bernard Shandley, 3 cts per ft. for main, ¼ ct. per ft. for laterals, 50 cts. each for basins, $2,342.50 total; Jos. H. Maillie, 3 cts., 1½ cts., $1.40, $4,102.50; Laurence Carey, 3 cts., 2 cts., $150, $4,667.50; W. R. Cook, 3¼cts., 2 cts., $1.74, $5,119.75; Dennis Byrnes, 5 cts., 4 cts., $2, $7,962.50. McCarthy & Kenney, informal.

Reservoir Outlet.—The following proposals for materials for reservoir outlet, Potomac river improvement, were opened Feb. 23 by Lieut. Col. PETER C. HAINS, U. S. Engineer Office, Washington, D. C.: Piles: Chas. S. Beebe, Baltimore, Md., 7 cts. per lin. ft., $2,730; L. A. Clarke, Occoquan, Va., 14¾ cts., $5,703.75; Breen & Feeley, Alexandria, Va. (informal) 12 cts., $4,680.—Lumber; Thos. W. Smith, Washington, D. C., $34.50 per 1,000 ft. B. M.—Pebbles; E. E. Burrough, Washington, $1.20 per cu. yd.; J. E. McCracken, Washington, $1.25 or $1.15 if unloaded in 24 hours, or $3 per day demurrage if detained longer: R. M. Miller, Washington, $1.74: Breen & Feely, Alexandria, $1.80.—Broken stone; D. L. Shoemaker, Washington, $1.55 per cu. yd., or $1.40 if Government assumes responsibility for care of vessel: H. P. Gilbert, Washington, $1.75, or $1.45 if Government supplies scows for transportation of material; G. B. Clark, Washington, $2.70.—Sand: E. E. Burrough, Washington, 75 cts. per cu. yd.; R. M. Miller, Washington, 98 cts.; J. E. McCracken, Washington, 99 cts., or 80 cts. if unloaded in 24 hours or $3 per day demurrage; Breen & Feely, Alexandria, $1.20: G. B. Clark, $1.50.

Engine House.—The following proposals for completing the engine house at the statue of Liberty, on Bedloe's Id., N. Y. H., were opened February 23, by Major D. P. HEAP, U. S. A.: J. G. Vaughan, Stapleton, N. Y., $10,880; Robert Moore, West New Brighton, N. Y., $11,400; Frank Rinschler, Stapleton, N. Y., $12,443; Philip Wolf, Stapleton, $12,888; P. J. McGuire & Co., 170 Greene St., New York, $12 975; Morris Jacoby, 1542 2d Ave., New York, $14,327.50; H. C. Livesey, 31-33 Broadway, New York, $14,800; J. H. Deeves & Bro., 156 E. 119th St., New York, $15,500; Francis H. Smith, 16-18 Exchange Place, New York, $15,800; Jas. Thompson, Rosebank, N. Y., $16,000; Linus Seely, Woodfords, Me., $16,532; E. D. Garnsey & Bro., 342 E. 34th St., New York, $17,500; D. C. Weeks & Son, Mott Ave. and 163d St., New York, $18,485.

City Halls.—*Cincinnati, O.*—The following lump sum proposals were received February 20: David Hammond, $508,900; Isaac Gravesen & Son, Cincinnati, $529,777; Driver & Bro., Hamilton, O., $587,538; Jas. Griffith & Sons, Cincinnati, $596,630. The City Hall Trustees have awarded separate contracts as follows: David Hummel, excavation, foundations, concrete and masonry, $326,506; M. Clements, iron work, $125,700; P. T. Scahill, interior concreting, $10,475; Jas. Hunter, copper and slate, $17,498; J. H. Finnegan & Co., fire proofing, $18,645; T. Schillinger, asphalt, $2,900. Total, $501,718.

Galveston, Tex.—The following proposals for city hall and market house were received by the Committee on Public Property, February 22: Frank Jones, Galveston, building complete, $41,193; stalls, etc., in market, $1,680 extra; fireproof ceiling for market, $3,684 extra; total, $46,557; H. Devlin, Galveston, $41,900, $1,300, $3,500, total $46,700; Barnes & Palliser, Galveston, $42,500, $1,750, $3,750, total $48,000; R. B. Garnett, Galveston, $43,450; $1,900, $4,500, total $49,850. The contract was awarded to Frank Jones at $41,193 for building complete, without fireproof ceiling; $1,680 for fitting stalls, etc., in market; total, $42,873.

Light Station.—The following proposals for rebuilding the tower of Skilligallee light station, Michigan, were received Feb. 20 by Maj. S. M. MANSFIELD, U. S. Lighthouse Engineer, Detroit, Mich.: Chas. Sundburg & Co., Chicago, $6,875; Jos. L. Gearing, Detroit, $7,694; Wm. E. Avery, Detroit, $7,725; Robt. Dunn, Detroit, $8,225; Thos. Hayden, New York, $18,500; Stout & King, Omaha, Neb., $41,238.

Timber.—The following proposals for white oak timber for lock gates for St. Mary's Falls canal, were received Feb. 18 by Lt. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.: Wm. R. Santley, Wellington, O., $54 per 1,000 ft. B. M.; Thos. R. Forsyth, Detroit, $75.75; C. J. Lloyd, Detroit, $79.50; Wm. T. Casgrain, Milwaukee, Wis., $88.

Pumping Engine.—No bids were received Feb. 20 by the Leavenworth City & Fort Leavenworth Water Co., the contract having been already let to H. R. Worthington, of New York. S. HASTINGS, Superintendent of Water-Works.

Water Meters.—The following proposals were received Feb. 27, by the Water Board, Boston, Mass., for (Lot A) 3,350 ¾-in. and 150 1-in. Tremont meters withdrawn from service, and (Lot B) 250 ¾-in. and 150 1-in Trem ont meters never used; W. W. Nichols, ⅝-in., $2.45 and $2.50 each for A and B; 1-in., $4.50 and $4.54 for A and B. Thos. Butler & Co., ¾-in., $2 each for A and B; 1 in. $3.80 for A and B; or 7½ cts. per lb. for all. American Tool & Machine Co., for 300 ¾-in., $1.98, $2.03 or $2.07.

Contractors' Supplies.—Ryan & McDonald, of Waterloo, N. Y., manufacturers of railroad contractors' supplies, have just completed one 5 ton, 30-in., light locomotive and are building another for Hiram Sibley, of Rochester, N. Y., to be used on his brick works at Maplewood, near that city. They report heavy contracts for dump cars, and other supplies for the opening of spring work.

Humphreys & Sayce, 1 Broadway, New York, dealers in railroad and tramway track material, have issued a pamphlet containing much useful information in condensed form. There are tables of weights of material; weights and capacities of cars; hauling capacity; weight, etc., of bolts, spikes, and other track material; rail fastenings; prices of locomotives; frogs and switches; estimates of cost of track; etc. There is considerable information relative to ordinary, light, logging and street railways; track; frogs and switches; locomotives; water stations; etc.; also a number of rail sections from 16 to 56 lbs. per yd.

To Architects.—It is announced that the time for receiving plans and specifications of a building for criminal courts, etc., proposed to be erected in the City Hall Park, New York City, is extended from March 1 to April 2.

Pumping Engines.—The Board of Public Works, Chicago, Ill., has issued the specifications for the new pumping machinery. They call for 5 engines, together with suitable pumps and the necessary boilers, all to be fully equipped for service. One engine and 3 or more boilers are to be completed and in running order by March 31, 1889, and 4 engines with 12 or more boilers to be in running order by March 31, 1890. Each engine, with not more than two-thirds the boiler capacity furnished must have sufficient power and capacity to raise from the inlet well directly into the pipe system of the city not less than 15,000,000 galls. of water in 24 hours, under a head equivalent to 125 ft. above the surface of the water in the well. The engines must be so constructed as to operate independently of one another. Proposals will be received only for vertical triple expansion engines with steam jacketed cylinders, having the pumps directly connected with the steam piston rods, and having single-acting outside packed plungers, except that quadruple expansion engines may be offered, and engines having less than 5 ft. stroke will not be as favorably considered as those having longer stroke. The engines shall be exactly alike in form and proportion. The duty required is not less than 100,000,000 lbs. of water raised 1 ft. high for each 100 lbs. of coal consumed in the furnace of the boilers, for a period of not less than 48 hours. In the performance of this duty the steam pressure must not exceed 125 lbs. per sq. in. Bids will also be considered with a higher boiler pressure, the bidders to specify the duty they guarantee. Proposals will be opened March 31.

The Paducah Iron Co. has been organized at Paducah, Ky., with a capital stock of $750,000. Ground will be broken shortly for the new works, and it is expected that a 200 ton furnace will be in operation by September. President, THOS. HOWARD, St. Louis, Mo.; Vice-President, W. W. POWELL, of Paducah; Superintendent, THOS. J. SCOTT; Secretary, HUGH MULHOLLAND.

Water.

San Buenaventura, Cal.—The Santa Ana Water Co. has lately added a pumping system to supply about 20 residences that are being built on high ground. There is a 20 H. P. boiler and a Worthington duplex pump with a capacity of 250 galls. per minute. The town is growing very rapidly and the indications are that the water consumption will be doubled in the next 2 years. E. P. FOSTER is Superintendent of Water-Works.

Water-Works.—*Maine.*—Gardiner. A line of water pipe, about 1,000 ft. in length has been successfully laid across the bed of the Kennebec river to connect the Gardiner and Randolph water-works systems. The work was done by H. G. Dennis, of New Bedford, Mass.

Massachusetts.—Boston. During 1887 about 22 miles of pipe were laid in outlying districts. The improvements at Lake Cochituate will be continued. There are now in use 436 miles of Cochituate mains, and 136 miles of Mystic mains.—Rockland. The water system will probably be extended to West Hanover; this would require about 3,000 ft. of pipe. The Water Commissioners have a bill before the Legislature providing for this work.

Connecticut.—The New Haven Water Co. has brought suit against the borough of Wallingford for retaining by a dam, water that would flow through Farm river to Lake Salstonstall. A mill owner has also brought a similar suit.

New York.—Lansingburg. The proposition to issue bonds for $25,000 for water-works has been defeated by public vote.—Albany. The 254 driven wells are being cleaned and tested; this will occupy about 2 months more, and then a test of all the wells connected together will be made.—Watkins. Plans for and a report on water supply and sewerage systems will be made by C. Ph. BASSETT, of Newark, N. J.—Phœnix. Plans for a combined direct pressure and gravity system of water-works are being prepared by Bassett Bros., of Buffalo. The works will be owned by a local company; President, J. G. VANDOREN, of Phœnix.

New Jersey.—Trenton. During the year 10,458 ft. of mains have been extended in the city, and 15,048 in Millham; 13 hydrants, 20 stop gates and 3 drinking fountains were erected. Superintendent BOYD suggested that all places using steam engines should have water meters.

Maryland.—Frederick. The proposition to increase the water supply by bringing water from the Monocacy river is meeting with much opposition. It is said that a storage reservoir could be built in the mountains for $10,000 to $15,000 which would furnish an ample supply for many years.—Centreville. The town proposes to issue bonds for $15,000 for water-works.

Ohio.—Cleveland. The total consumption for 1887 was 8,127,146,648 galls.; there were 22 miles 3,748 ft. of pipe laid and 257 fire plugs set.—Norwalk. The sum of $50,000 is to be spent in improving and extending the pipe system, enlarging the works and purchasing new pumping engines.—Martin's Ferry. The new water works were opened Jan. 7. There is a pumping station and well, a reservoir with a capacity of 3,000,000 galls.; duplex pumps by Gordon & Maxwell, of Hamilton, O., and 10 miles of pipe. The reservoir is at an elevation of 294 ft. and the pressure in the town is 110 lbs. The pipe system will be extended during the year. The engine house is large enough for pumping plant for a population of 60,000, and the reservoir capacity can easily be increased by building the dam higher. GEO HORNUNG is the engineer.

West Virginia.—Grafton. The question of establishing water-works will be voted on, March 20. Plans are being prepared.

Virginia.—Richmond. Appropriations have been made of $28,000 for extending the water-works, and $19,000 for a new pumping station.—Norfolk. Pipe laying will be pushed rapidly, and will be completed early in April.—Gordonsville. A senate bill has been passed to amend the act authorizing the city to issue bonds for water-works.

Kentucky.— Paris.

EDITOR ENGINEERING NEWS:—We have special act of Legislature authorizing council to submit vote (for approval) to the taxpayers, for a contract on our part (the council) previously agreed upon; the works and plant to be constructed by a company. Annual rental for city purposes not to exceed $3,000. Another act for sewerage system, not to exceed $10,000. Will probably submit vote within 30 days, no doubt as to its being favorable to the project. Would like to have propositions before us, with authorized representative present, within 10 days. The present supply is from wells, cisterns and water courses; the proposed supply is from water course surrounding the city. We think best to pump to stand-pipe. Hydrant pressure to be used for fire purposes. We will try and let contracts during month of March. W. B. CHAMBERS, Chairman of Water-Works Board.

Georgia.—Americus. The City Council has appointed U. B. HARROLD, J. B. FELDER and GEO. W. GLOVER a committee to arrange for the construction of the water-works. They are waiting to hear from contractors.

South Carolina.—Charleston. Work is progressing on the third artesian well and the new reservoir is being built. During the year 1,112 ft. of 6-in., and several hundred feet of 2-in. pipe were laid.

Alabama.—Eufaula. An injunction has been obtained by a mill owner to restrain the Eufaula Water Co. from taking waters from Little Chewalla creek and the Shorter Springs branch. The works have only recently been completed.

Michigan.—Capac. Water-works are projected.—Iron Mountain. The new water-works will cost about $80,000. Proposals will be received until April 2 (See advertisement.)

Illinois.—Loda. Water-works are projected.—Greenville. The water company is laying pipe, the supply will be from artesian wells.—Wrights Grove. Water bonds for $50,000 are for sale.

Minnesota.—Duluth. The Duluth Water & Gas Co., will build a larger reservoir, build new gas works, and extend the water and gas mains. About $500,000 will be expended.

Kansas.— Arkansas City, Feb. 23, 1888.

EDITOR ENGINEERING NEWS:—We are now putting in (to be completed by May 1) extension of 6 miles, on which will be 50 Bordas patent Bourbon hydrants. L. P. ANDREWS, Secy., Ark. City Water Co.

Leavenworth. A bill has been introduced to authorize the water company to purchase land on the fort reservation for 2 additional reservoirs.

Colorado.—La Junta. Work has been commenced on a tank with a capacity of 50,000 galls. for water supply.—Manitou. The water-works have been completed and tested. Water is taken from Ruxton creek, 2 miles above the town. The works cost $40,000.

Nebraska.—Hebron. A system of water-works has been decided upon. Electric light plant is also to be put in.

Oregon.—Arlington. Parties have made propositions to put in water-works. Address E. J. KEENEY, Arlington.

California.—Colusa. A tank 80 ft. high for fire pressure only, is to be erected. J. B. COOK, Superintendent

Texas.—Paris. The water company is putting in an auxiliary gang well system of 50 wells, 2½ ins. diameter and 75 ft. deep. This system will furnish a daily supply of 3,000,000 galls.—Kyle. The water-works will be completed in May.

Canada.—Cote St. Antoine, Que. The directors of the Cote St. Antoine Water Works Co. have created a reserve fund for extensions. There is considerable loss from leakage, President, A. C. HUTCHISON.

Lewistown, Ill.— Feb. 22, 1888.

EDITOR ENGINEERING NEWS: The water-works will be commenced March 1, and will be completed by June 1. The contracts were let last week, as follows: masonry and foundations, J. W. Bradley and T. M. Mercer, of Lewistown; buildings, J. W. Bradley; pumping machinery, Knowles Steam Pump Works, New York; pipe and specials, Lake Shore Foundry, Cleveland, O.; trenching and pipe laying, not let yet; valves and hydrants, National Tube Works Co., Chicago; stand-pipe, 12 ft. diameter and 36 ft. high, T. M. Mercer; the contract for tanks has not been let. The designing and constructing engineer is GEO. C. MORGAN, of Chicago. The mains will be 8-in. iron, service pipes 3, 4 and 6-in. There will be 5¼ miles of pipe and 23 fire hydrants. Ordinary pressure, 100 lbs., fire pressure, 150 lbs. The works will cost $30,000; debt, $15,000; rate of interest, 6%. The supply will be taken from drive wells and pumped to tank. Population, 2,000. The works will be owned by the city (within corporate limits) and the Lewiston Water Co.; President, HENRY PHELPS; Secretary, H. C. HASSEN; capital stock, $15,000.
GEO. H. LINTON, *City Clerk*

New Brunswick, N. J., Dam Broken. The dam of the city water-works on Lawrence Brook, which broke on Feb. 25, was first built in 1743, and a second wall was built over 100 years ago. It gave way from "inherent weakness." The break cuts off the city water supply and permission has been asked to fill the Delaware and Raritan canal for use in a fire emergency.

Water Meters.—The city of Newton, Mass., has appropriated $3,500 for the purchase of water meters.

Water Waste.—At Meriden, Conn., water consumers have been requested to leave the faucets open during cold nights to prevent freezing. The superintendent prefers to waste some water rather than have breaks in the pipes.

Iowa Water-Works.—Mr. Townsend has introduced a bill in the State Legislature, at Des Moines, providing that cities of the first class may issue bonds, not exceeding 5 per cent., of the assessed valuation, for building water-works.—A Senate bill has been passed giving citizens of towns the right to issue bonds for water-works, instead of vesting that power in city councils, as at present.

A Large Dam.—It is proposed to obtain water power near Appleton Wis., by building a dam in the river just below Little Chute. It will be about 850 ft. long, and in some places 26 ft. high: there will be sluices and gates for about half the length. The surveys and plans have been made by Edwards & Orlison. It is estimated that the reservoir thus formed would furnish 7,000 H. P. during stages of low water, and from 7,000 to 10,000 H. P. during the greater part of the year.

Irrigation.—*Idaho.*—The Boise & Nampa Canal Co. has been organized to construct an extensive irrigating canal. This canal will run from the Boise river, 5 miles above Boise City, to the Snake river: it will be 80 miles long, 30 ft. wide at the bottom and 5 ft. deep. About 300,000 acres of land will be irrigated, and water will also be supplied for working placer mines on Snake river. President, Gen. J. F. CURTIS, Boston, Mass.; Vice President and General Manager, Col. E. S. NETTLETON, State Engineer of Colorado; Secretary, J. A. MCGHEE, Nampa.

Colorado.—The Estes Park Reservoir & Water Supply Co. has been incorporated at Denver by CHAS. C. WELCH, J. C. HAMNEL and ALEX. Q. MCGREGOR, to build reservoirs and take water from Big Thompson creek, Fall river, and other streams, for irrigation purposes. Capital stock, $50,000.—The Surface Creek Ditch & Reservoir Co. has increased its capital stock to $4,000.

California.—An irrigation district is to be formed in northern Yolo county, to connect with the Central Irrigation District of Colusa county, and to extend the Colusa canal through Yolo county to Cache creek.—The San Joaquin Land & Water Co., the object of which is to take water from the Stanislaus river for irrigation purposes in San Joaquin county, has recently purchased several water claims.

Arizona.—ROBT. MCPHERSON, of McPherson, Los Angeles county, is President of the McPherson Canal Co., which proposes to bring water from the Gila river for irrigating about 80,000 acres of desert land near Gila Bend. He has also large interests in the St. Louis canal, which conveys water from the Salt river for irrigating in the Salt river valley, near Phœnix, Ariz.

Texas.—A stock company composed of California capitalists has been organized at Pecos City to build an irrigation ditch about 100 miles long. Surveys are being made and work will be commenced as soon as they are completed.

Ohio Water-Works.—Mr. Mehaffey has introduced a bill in the State Senate which provides for placing the water-works of cities and villages in the control of city councils. The councils must appoint trustees, fix the salaries, etc., and the trustees must keep accounts of the water rents paid by each consumer.

Newark, N. J.—The following is the estimate of cost of the new pumping plant, mains and reservoir, for which the Common Council has authorized the expenditure of $450,000 by the Aqueduct Board:

1.	New high service pump and extension to the pumping station, which should be commenced without delay	$ 35,000
2.	The storage reservoir, to be commenced so that it should be ready in 1890	150,000
3.	The new 24-inch distributing main from distributing reservoir to low service, to be completed in June, 1889	55,000
4.	The new 36-inch supply main from receiving reservoir in Belleville to the storage reservoir, to be completed in 1890	165,000
5.	Alterations to the Belleville reservoir, to be commenced in 1889 and completed at the same time as the 36 inch main	25,000
6.	Two additional boilers to the Belleville pumping station, with extension to boiler house, to be completed in the early part of 1889	10,000
		$440,000
	Contingencies	10,000
	Total	$450,000

According to the above the amounts of money would be called for as follows:

In 1888	$100,000
In 1889	240,000
In 1890	110,000
Total	$450,000

Artesian Wells.—*Atlantic City, N. J.*—The Atlantic City Gas & Water Co. is boring an artesian well and has reached a depth of 1,100 ft. It is expected that water will soon be reached.

Waukesha, Wis.—An artesian well is being bored to supply the village with water. It is 10 ins. diameter at the top, diminishing to 6 ins.: it is situated on the west bank of the river, only a few yards from the edge. It is expected to reach water at a depth of 1,400 or 1,500 ft.

Wilmington, N. C.—The water company will sink an artesian well to supply drinking water, which is not now furnished.

Darlington, N. C.—Geo. C. Cunningham has a contract for an artesian well.

Fort Payne, Ala.—The Fort Payne Land & Improvement Co. has a number of wells to be put down, and will let contracts as soon as possible.

Trinity, Tex.—An artesian well is being sunk by the International & Great Northern R. R. Co.

Palestine, Tex.—The Palestine Ice Co., J. R. COOK, Manager, is putting down an artesian well. It has reached a depth of 240 ft. Engineer MAYO is in charge.

Santa Fé, N. M.—A company is sinking an artesian well, and has it down 100 ft.; work is progressing about 15 to 20 ft. per day.

Glencoe, Ont.—The test well is down 1,020 ft. but there is no indication of water. The council has let the contract to have it bored to a depth of 1,500 ft. The experiment will cost $2,500.

Victoria, Tex.—The well boring plant of O'Connor Bros., of Refugio county, has been delivered and will be used for boring wells on the large ranches in that county.

Saguache, Col.—An artesian well is proposed in Saguache county, and the County Commissioners are asked to appropriate $1,000 towards the cost. Address H. M. MINGAY, editor of the Saguache *Democrat*.

Memphis, Tenn. Feb. 22, 1888.

EDITOR ENGINEERING NEWS: Agreeably to your request I enclose you a slip setting forth facts up to the present about as they are, except that we opened well No. 6 last night, and it is a "gusher." We will soon have 8 connected. C. MONJEAU, Secy. & Manager.
National Water Supply Co.

The following information is abstracted from the slip sent us by Mr. MONJEAU: The Memphis Water Co. and Artesian Well Co., were consolidated Feb. 18; both companies preserve their identity and full organization, but the common management will be in the name of the Artesian Well Co. Its former stockholders own $250,000, and those of the Memphis Water Co. own $500,000 of the stock. Last summer a contract was made by the latter company with the National Water Supply Co., of Cincinnati, O., for an artesian plant of 12,000,000 galls. daily capacity. This contract has resulted favorably, there are 5 (now 6) flowing wells averaging 400 to 450 ft. deep and capable of yielding about 3,000,000 galls. per day. The contractors now promise two additional wells every week. During the progress of this work the Artesian Co., has met with equal success, and by uniting the 2 plants and connecting them with the 36-in. and reinforcing mains, it is hoped to have a 4th of July celebration over the new water supply. Plans and specifications have been prepared for the stand-pipe and bids will be asked for at once. President, T. J. LATHAM; Vice President, R. C. GRAVES; Secretary, LAWRENCE SIMPSON. Of the new board of directors, 6 are from the Memphis Water Co. and 5 from the Artesian Well Co.

Valley Falls, Kan. Feb. 10, 1888.

EDITOR ENGINEERING NEWS: Work has been commenced on the new water works and is to be completed by July. There is a large well 300 ft. from Delaware river, supposed to be connected with the river by bed of gravel. The U. S. Wind Engine & Pump Co., of Batavia, Ill., is building the works for the city: the probable cost is $15,300 and capital is secured by bonds of the city at 7%. The contractors furnish their own engineer. C. C. LORD is chairman of the water works board; H. C. BUTTS, City Clerk. The pipe is of cast-iron, 6 in. main and 4-in on cross streets; 1¼ miles of pipe, 12 hydrants. Water will be pumped to a tank 20 ft. by 30 ft. on stone tower 35 ft. high on hill 75 ft. above main street, making total height of water supply above main street (Broadway,) 105 ft. to bottom of tank. The well is 30 ft. deep, 16 ft. in diameter, the city is building the well by day work, all other work is included in contract with above parties, including hose cart and 100 ft. hose. Population 1600. The present supply is from wells. C. C. LORD.

Burnet, Tex.— Feb. 13, 1888.

EDITOR ENGINEERING NEWS: In summer of 1887, and during the severe drouth that was then prevailing, our citizens petitioned the City Council to levy a tax for the purpose of sinking an artesian well or wells, and to be gradually worked up into a system of water works. The Council took hold of the matter and appointed a committee. Said committee, after trying all the local well diggers, instructed me to advertise for bids for said well. I did so, and when I presented the result to the committee they made their report to the Council, and there the matter has rested ever since, the Council having taken no action more than to lay the matter over for future consideration. In my opinion the Council finds the matter rather too heavy a burthen to take up just now, and will leave it open for private enterprise, should anyone see fit to engage therein. It is a fine opening to anyone having the capital and disposed to engage therein. The present supply is from ordinary wells. The population is about about 1,200 to 1,500. WM. M. SPITLER.

Missouri Valley, Ia.— Feb. 13, 1888.

EDITOR ENGINEERING NEWS: The present water supply is obtained from drive wells from 40 to 75 ft. deep, and the proposed supply is also from drive wells, the water to be probably pumped to reservoir, and hydrant pressure to be used for fire purposes. The works will cost about $25,000, and will probably be built by a private company, but no company is yet organized. Population of town, 3,000; census of 1885 gave us 2,375. The city voted to bond itself to the amount of $25,000, and put in water-works on its own account, but our assessed valuation is very low, real estate at ⅓ and ¼ of its actual saleable value and in the main still less, consequently the city could not bond itself for that amount without increasing the valuation, which cannot be done until January, 1889. They have therefore decided to grant a franchise to some responsible company and have the works put in that way. A good portion of the capital could be raised here if necessary; committee has been appointed to correspond and ascertain terms, etc. WM. H. FENSLER is chairman, and can give further information. Our source of supply would be drive wells. The city is putting one down now right in the heart of town, where they own a lot. It will be 50 ft. deep or near that. It is very good water, but hard; by going to the edge of town the same water can be had at 40 ft., and by going down 75 ft. a sand layer is found with an inexhaustible supply of pure soft water. The town lies at the foot of bluff deposits which rise almost perpendicular to a height of 200 ft., and on them it is expected to erect a reservoir. We would probably need about 4 miles of main.

J. S. MCGAVREN, *City Clerk.*

Fort Benton, Mont. Feb. 12, 1888.

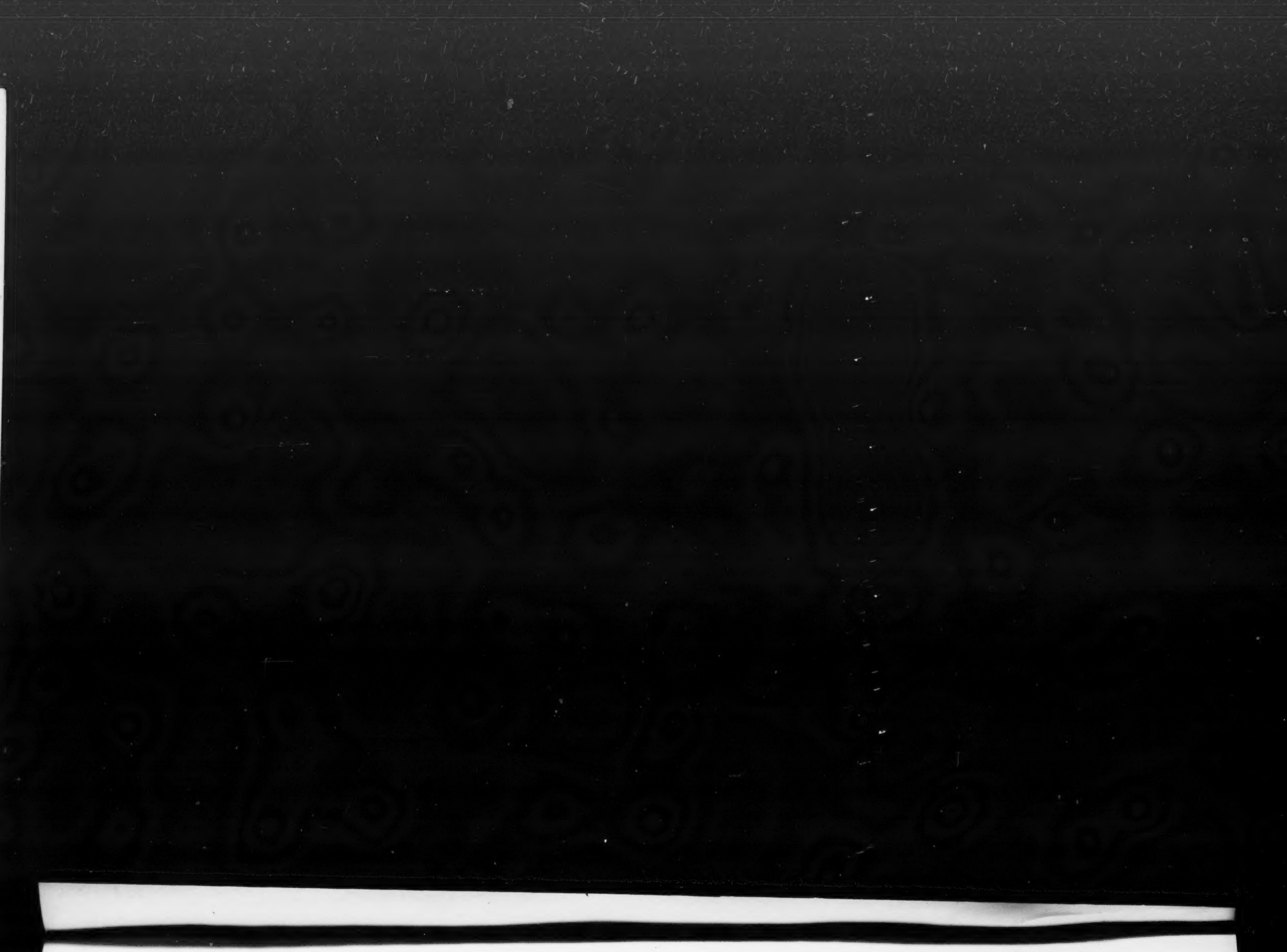
EDITOR ENGINEERING NEWS: My works here are completed, both water and electric light. I am constructing the works at Helena, this territory, under franchise obtained by me and given to a Boston company. They will be completed in one month or 6 weeks. I have just obtained franchise at Bozeman, this territory, and works will be put in this year.

GEO. F. WOOLSTON.

The Sam Christian Gold Hydraulic, Limited.—The works for this mine are being pushed forward as rapidly as possible. Messrs. H. R. Worthington, of New York, have taken the contract for the pumps, and they are accounted the best firm in the world for such a business. Mr. Hambley continues his prospecting operations with most encouraging results. In four days' sluicing, quite recently, he got over 70 cts. of gold to the cubic yard, and this it must be remembered is nearly three times as good as the estimate on which he based his original expectations of enormous profit. When it is remembered that the Sam Christian property comprises 1,350 acres of rich alluvial, not to mention the ultimate certainty of rich quartz reefs, the value of it appears almost incalculable.—*St. Stephen's Review*, Feb. 11, 1888.

Detroit, Mich., Feb. 21.—"An attachment was issued yesterday against the Grand Rapids Hydraulic Co., to secure a claim of $10,657 held by John Hull Browning, a banker of New York City." The above is from the New York *Times* Feb. 22, which paper gave the full particulars of the case.

Water-Works Reports

Fall River Mass.—The Watuppa Water Board have issued their report for the year 1887, being the 14th annual report. The need of larger distribution mains is again strongly urged: an immediate commencement of the work is recommended. The works were built by the city in 1874. The supply is obtained from Watuppa Lake and pumped to stand-pipe and tank. The pumping machinery includes engines by the Boston Machine Co., H. R. Worthington of New York, and the Davidson Steam Pump Co., of Brooklyn, N. Y.; the total daily capacity is 13,000,000 galls. The total amount pumped during the year was 580,700,532 galls. The estimated population in 1887 was 64,000; estimated number of consumers, 60,000. Percentage of consumption by meter, 41.4. During the year, 990 ft. of 12-in. and 3,940 ft. of 6-in. were laid; 7 hydrants and 5 gates were set; also 211 services and 216 meters were added. The system now comprises 315,357 ft. of 6-in. to 24-in. cast-iron distribution pipe, 613 hydrants, 617 gates, 2,941 meters and 6 motors for elevators. There are 4,197 services; the service pipes are of lead, from ¾-in. to 2 ins. diameter. The quality of the water has been good and no complaints have been made concerning it. The pumping engines are reported to be in first class condition. The report contains tables of work done, consumption for a term of years, monthly distribution during 1887, rainfall, financial statement, etc. There is also a diagram of the water pumped and the height of the lake during the last 14 years. WEAVER OSBORN is President of the Water Board. PATRICK KIERAN, Superintendent.

Hudson, N. Y.—The Board of Water Commissioners have issued their report for the year ending Sept. 30, 1887, being the 15th annual report. The Legislature passed an act in April, 1887, authorizing the city to borrow $40,000 for a new filtering reservoir and a new force main. At the time of the report the new main, 16 ins. diameter, was nearly in position, extending about 7,800 ft. from the river to the new reservoir. The new reservoir was nearly completed; its capacity will be 1,500,000 galls. above the sand and when completed the works will be able to supply 2,500,000 galls. of filtered water per day. During the year, 392 ft. of 4-in pipe were laid, also 2 hydrants and 2 gates set. There are now 76,510 ft. of 1½ in. to 18-in. pipe 185 hydrants and 110 gates. The total consumption for the year was 462,756,389 galls. The report includes a financial statement and table of consumption. WM. H. TRAVER is President of the Water Commissioners; JOHN S. RAY is Superintendent.